APPENDIX A

MEMORANDUM

304 12th Street, Suite 2A
Oakland, CA 94607
(510) 540-5008
www.altaplanning.com

To: Fanny Yu, City of Milpitas

From: Erin David, Alta Planning + Design

Date: October 28, 2019

Re: Milpitas Bicycle, Pedestrian, and Trails Master Plans Existing Conditions Summary

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Introduction

The Milpitas Bicycle and Pedestrian Master Plan and Trails Master Plan updates will provide a vision and action plan for the City to improve safe and convenient travel by active transportation modes for everyone, regardless of age, ability, or background. Milpitas has grown significantly in recent years, both in terms of population and industry, and these plans can help improve quality of life in the city through more transportation options and new connections with the region. A new BART station and other transportation investments will provide the City with an opportunity to alleviate congestion, improve recreational opportunities, and enhance safety for all people regardless of how they get around. The following memorandum explores the existing conditions for walking and bicycling in Milpitas, current demographic and employment data, and policy context.

Community Context

The City of Milpitas is located in Santa Clara County at the southern end of the San Francisco Bay. It is situated directly north of San Jose and is located southeast of Fremont, covering over 13 square miles. Immediately east of the city is the Calaveras Valley, where a variety of County parks, regional preserves, low-density housing developments, and other local amenities are located.

Within Milpitas, land use patterns respond to primary through-ways, such as the rail line, I-680, and I-880, which run north-south across the city. Industrial and commercial land uses are located primarily along these routes, and the roadway patterns are focused on vehicle movement. State Route 237 runs east-west through much of the city, creating an additional barrier to bicycle and pedestrian travel.

Existing land use in Milpitas is predominantly residential, with single-family homes comprising approximately 75% of all housing units.[1] Residential land uses are located between major arterials and along a series of winding roadways. The existing roadway pattern in these areas provide minimal connectivity for all modes, especially in areas where cul-de-sacs are present.

[1] 2017 ACS 1-year estimate

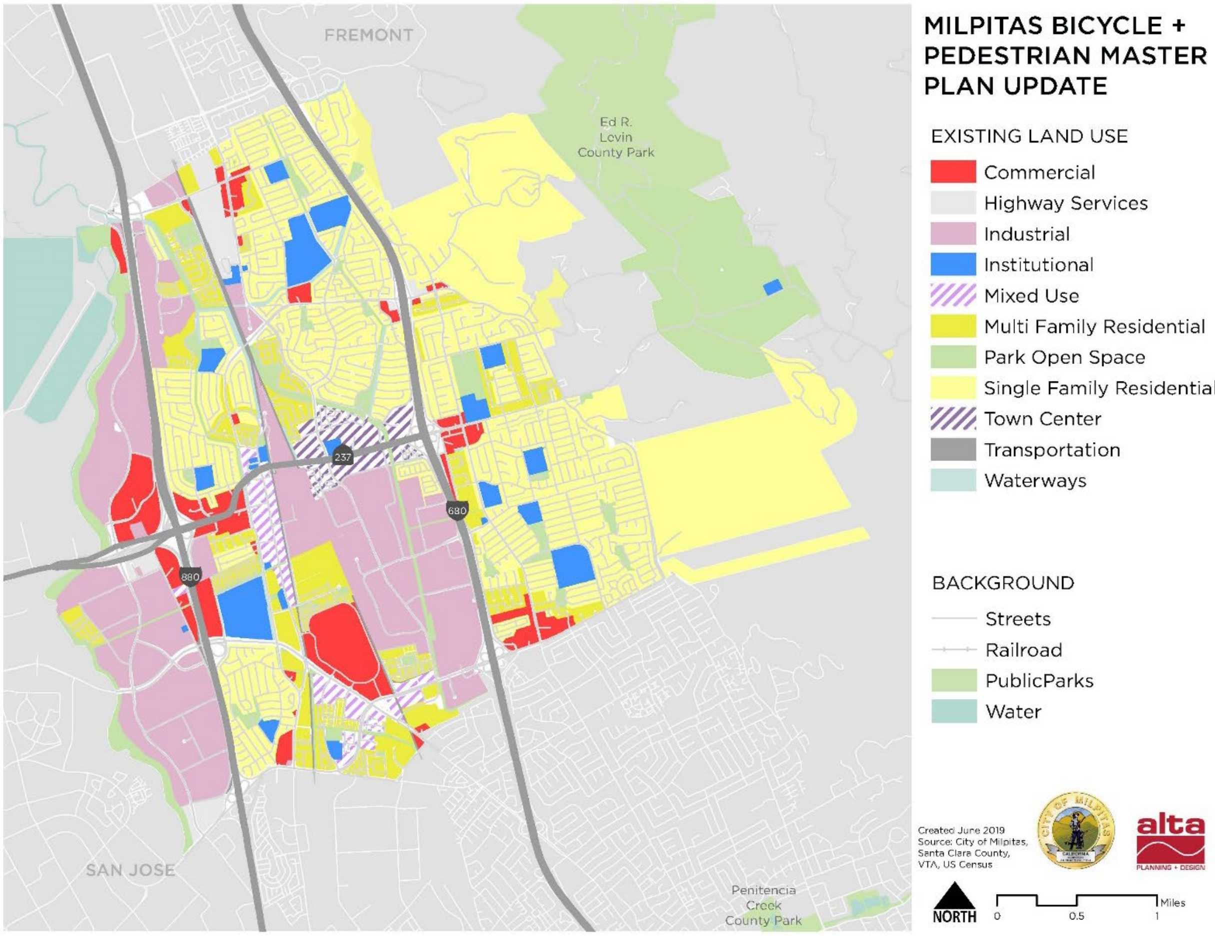

Figure 1: Existing Land Use

In general, commercial and industrial areas are located in the south and west of the city, with only a few commercial land use nodes mixed within residential areas. Access to services such as groceries require travel along major roadways that are not comfortable for those on foot or bike, particularly as they are located outside of residential areas.

The industrial land uses represent major job centers and are typically separated from residential and institutional uses by major highways. Typically located on large parcels with limited points of access and large parking lots, connectivity through and among industrial land uses rely on motor vehicle use for even short trips. Contending with driveways, sharing the road with motorists traveling at high speeds, and out of direction travel can negatively impact the choice to make a trip by foot or by bike. Increasing connectivity, such as through connecting street ends or pathways across large parcels, can increase the availability of lower stress routing for bicyclists and pedestrians. This also improves the directness of routes available, making these trips more appealing.

According to the CA Department of Finance,[2] Milpitas has an estimated population of 76,231 as of January 1, 2019. This is an increase of over 16% since the 2010 Census. Milpitas experiences an increase in its weekday daytime population—nearly doubling the population[3]—due in part to several large employers located within the city. The majority of the population is under the age of 65, with only 10% of the population aged 65 years or older. Nearly 25% of the population is under the age of 18. Although the

[2] CA Department of Finance annual population estimate, 2019
[3] City of Milpitas. http://www.ci.milpitas.ca.gov/milpitas/about-milpitas.

majority of the population is between the ages of 18 and 65, those under and 18 and those over 65 are often the most vulnerable road users; specific opportunities to provide safe routes for these populations can improve opportunities for safe access to schools and services.

The population is generally affluent and well-educated, with over 50% of the population having a Bachelor's degree or higher; over 90% of the population has at least a high school diploma. The median household income is nearly $128,000, approximately 1.5 times higher than the median household income for the State of California and 10% higher than the larger San Jose-Sunnyvale-Santa Clara metropolitan area.[4] The majority of households in Milpitas have an income of at least $75,000.[5] Further, the population is racially diverse, with Asian populations representing over 60% of the city. More than 70% of all households speak a language other than English.

Transportation Overview

Transportation options in Milpitas are varied, including bicycle facilities, sidewalks and pathways, numerous bus lines, and light rail. Despite the wide range of modes available, individuals primarily commute to work by driving alone. Over 78% of the working population drive alone to work; an additional 11% of the working population carpool. While over 80% of households in Milpitas have access to two or more motor vehicles, nearly 2% of households do not have access to a motor vehicle. Those without access to a motor vehicle often rely heavily on transit, walking, and bicycling. High quality bicycle and pedestrian networks that connect destinations and provide access to transit not only provide mobility options for those without motor vehicle access but can also increase options available to those relying on motor vehicles today.

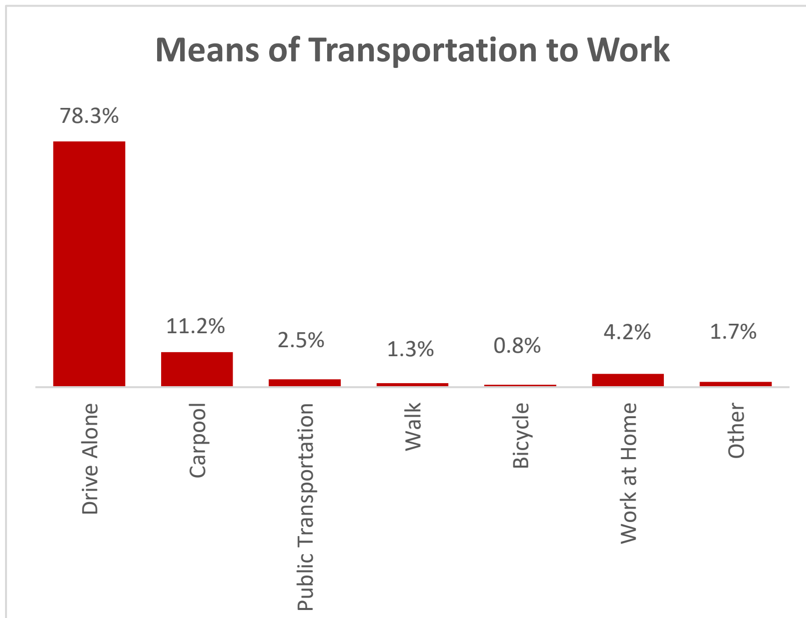

Figure 2: Means of Transportation to Work

In addition to supporting local traffic, several major roadways—including State Route 237, Montague Expressway, and Great Mall Parkway—support regional trips both into and out of Milpitas. Improvements should consider the regional role of these roadways while still seeking to improve safety and access for active modes.

Public Transportation

Transit is the next most used commute mode; however, only 2.5% of the working population utilizes public transportation options. The network is supported by bus and light rail service, and the Milpitas BART station will be opening at the end of 2019 in the southern part of the city. The addition of BART will connect Milpitas with the region; not only will residents have improved access to nearby cities, but those traveling to Milpitas will need ways to get around without a motor vehicle when they reach their

[4] 2017 ACS 1-year estimate
[5] City of Milpitas. http://www.ci.milpitas.ca.gov/milpitas/about-milpitas.

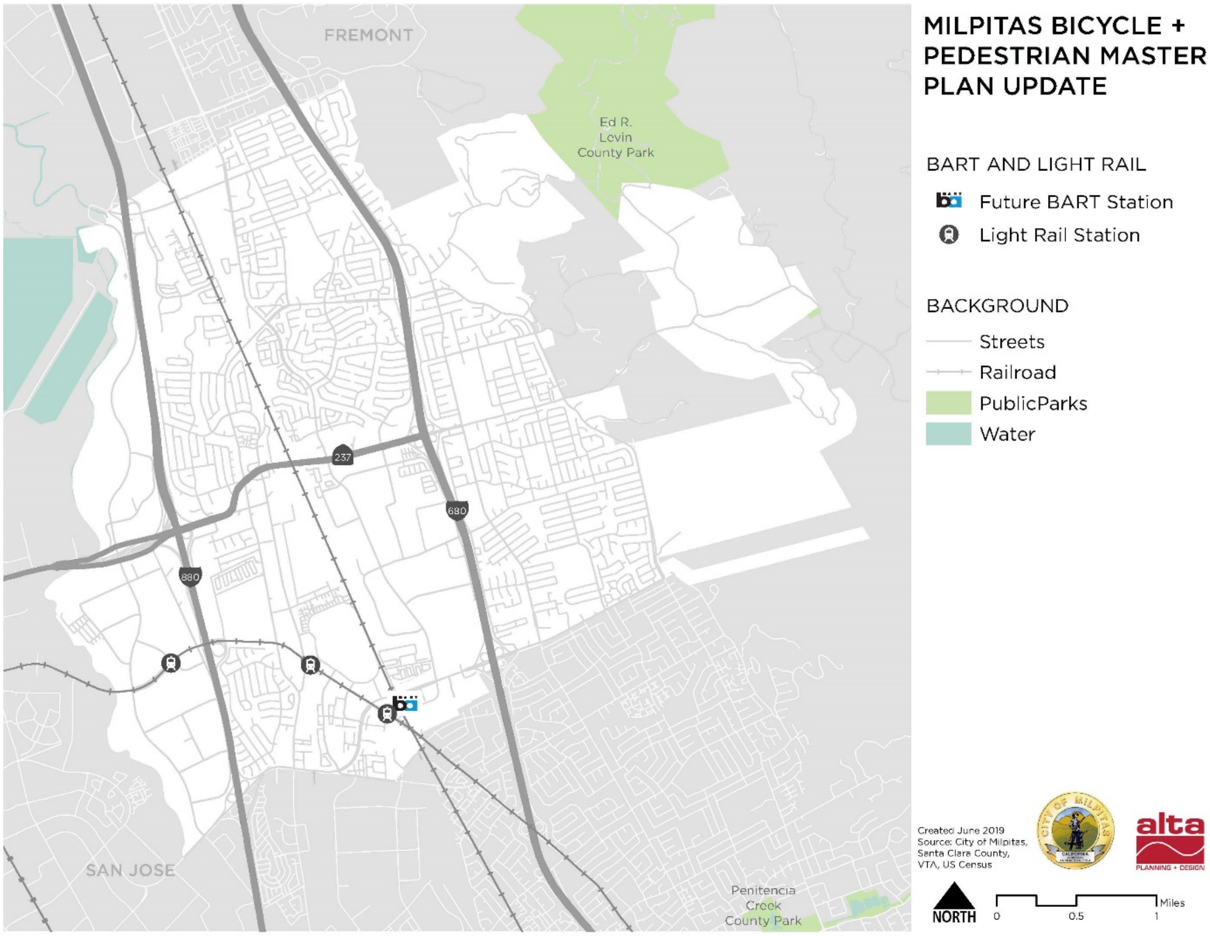

Figure 3: Light Rail and BART Station Locations

destination. Bus and light rail are currently operated by the Santa Clara Valley Transportation Authority (VTA). Additional bus lines providing service in the city are operated by AC Transit.

The Alum Rock – Santa Teresa light rail line includes stops in the southern area of Milpitas. Stops are located along E Tasman Drive and E Capitol Avenue, with three stops within Milpitas city boundaries. The I-880 Milpitas Station and the Great Mall/Main Station have park and ride lots available; the Montague station is located near the future BART stop. Opportunities to increase bicycle and pedestrian connectivity to transit and implement Transit Demand Management (TDM) strategies envisioned in the Transit Area Specific Plan should be explored.

The Milpitas BART station will be served by two routes (Richmond to Warm Springs/Fremont and Daly City to Warm Springs/Fremont), with service every 7.5 minutes. The station will provide easy connections to bus service and the light rail line. Projected to have 20,000 daily passengers by the year 2030, this station will be a major transportation hub in the city. Along with the station area development, VTA has also proposed a series of bicycle and pedestrian complete streets projects for the Tasman Drive Corridor. Within Milpitas this includes the addition of a bike path (Class I facility) along portions of Tasman Drive/Great Mall Parkway, a new bike/pedestrian bridge over I-880, and new bike signals to improve movement along the corridor. These improvements will also support connectivity in some locations, such as improving connections to the Coyote Creek Trail.

Bicycle Network

The existing bicycle network represents nearly 50 miles and consists of bicycle lanes (Class II), designated bicycle routes (Class III), and paved pathways (Class I). This network is shown in Figure 4 below. It should be noted that while Class III facilities are displayed as part of the network, these shared roadways are frequently along major arterials or are co-located with truck routes, presenting many challenges to safe and comfortable travel by bike. Through this planning process, opportunities to increase the comfort and safety of designate bicycle routes (Class III) should be explored.

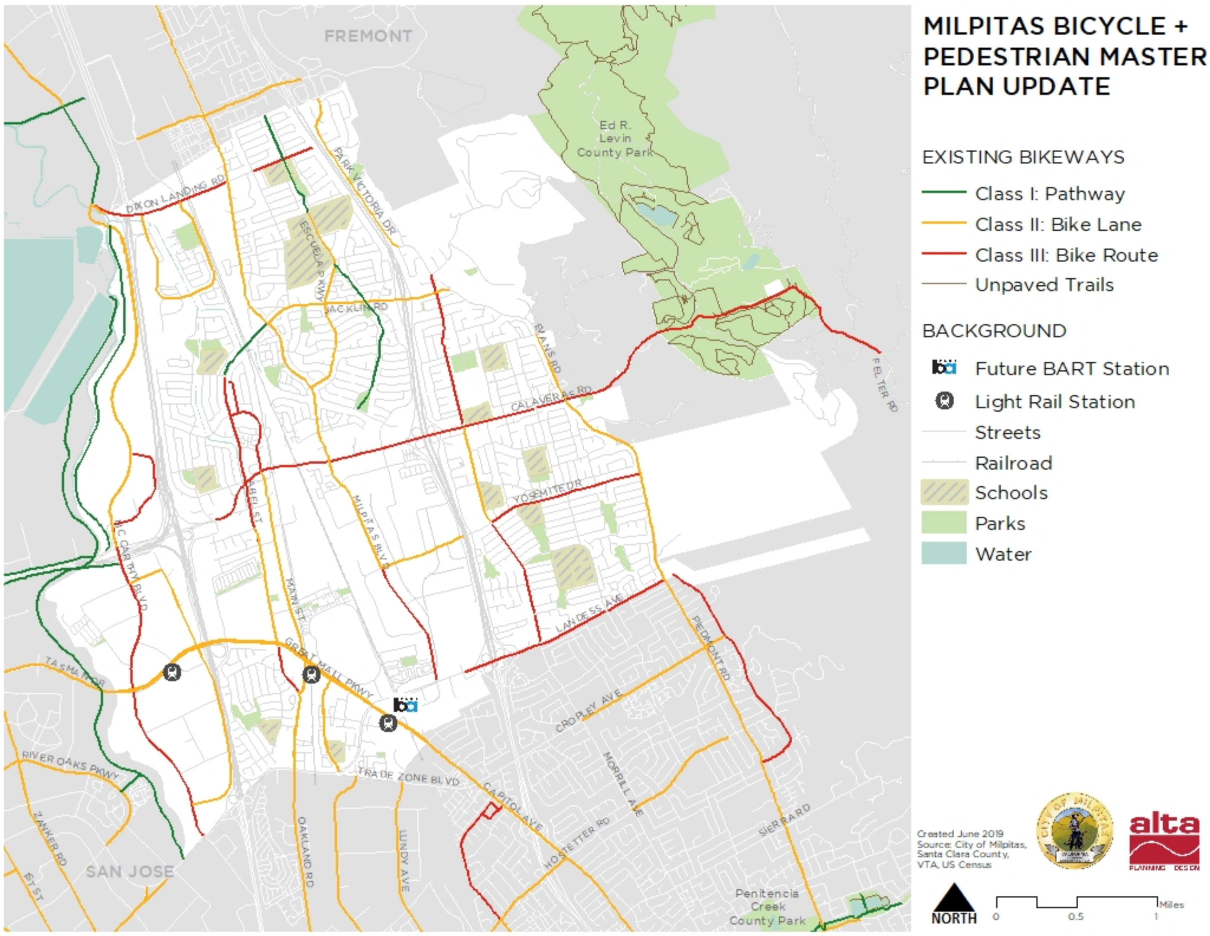

Figure 4: Existing Bikeways and Trails

While Milpitas currently does not have a bike share system in place, company campuses may have options available for their employees. Bike share systems make bicycles readily available to residents for short-term rentals, often based on a per trip fee or a daily or monthly subscription. Bike share systems support first-last mile connections to transit and increase mobility options, especially for short trips.

Bike lockers, which can support connections to transit or other destinations by a personal bike, are available at both the Great Mall Light Rail Station and the Montague Light Rail Station. Other features, such as wayfinding systems, that support multi-modal and active trips are not currently in place but should be explored.

Pedestrian Network

Data specifying sidewalk location through the City of Milpitas was not available. Shared use pathways and trails support pedestrian travel throughout the city, and review of aerial imagery indicates that the sidewalk network is complete in many locations throughout the city. Street Design Guidelines for the City specify that streets shall include sidewalks with curb ramps. However, it is important to note that cul-de-sacs, high speed arterials and limited access highways, and large parcels limit the connectivity and directness of pedestrian routes.

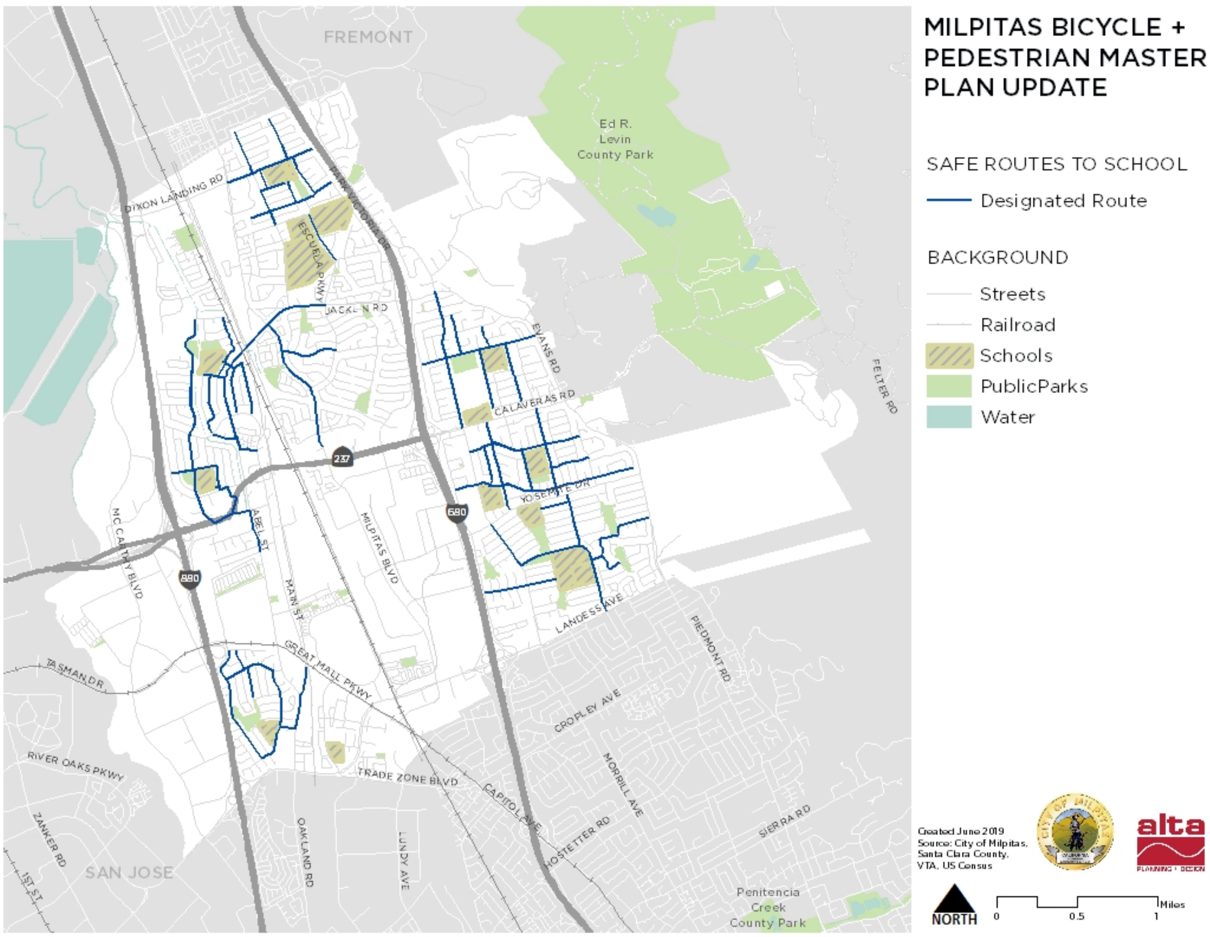

Figure 5: Safe Routes to School

The City has designated Safe Routes to School for 11 schools, totaling nearly 45 miles of roadways. These routes typically follow neighborhood roadways, which are lower speed and lower volume, or include segments of Class I (paved pathway) facilities. However, several segments are located along higher speed roadways, such as Abel Street. With children comprising approximately one-quarter of the total population in Milpitas, and children often more vulnerable to crashes than adults, opportunities to improve these routes through separation from motor vehicles and safe crossings should be explored.

Trails

In addition to the facilities noted above, a number of trails provide recreational opportunities in Milpitas and support the transportation network. There are over 20 miles of unpaved trails in Ed R. Levin County Park on the east side of Milpitas, and unpaved segments in the west of the city run alongside Coyote Creek's paved pathway. Coyote Creek Trail is a designated segment of the San Francisco Bay Trail, connecting bicyclists and pedestrians to a regional network of trails and pathways.

The San Francisco Bay Trail is an effort to establish walking and bicycling facilities around approximately 500 miles of the San Francisco Bay with the goal of connecting communities to parks, schools, and transit. It is comprised of a series of on-street, paved off-street, and unpaved off-street segments. To date, 350 of the 500 miles are designated and available for use; the trail miles not yet available for use are proposed, with alignments dependent on jurisdiction coordination, funding availability, and construction. Proposed segments in Fremont and San Jose will improve connectivity among these cities and create opportunities for greater connectivity with Milpitas.

The Coyote Creek Trail is located to the west of I-880 along the western extent of the city. The highway creates a barrier for access to the trail without a motor vehicle, as the existing bikeway system does not provide a low-stress connected route to the west. Travel west across I-880 is limited to a few high-speed roadways that also require bicyclists to navigate on- and off-ramps from the highway. While trailheads with parking are available along the trail, improved multi-modal connections can make the trail more accessible for all residents. The trail currently provides connections to the light rail system, and proposed improvements along Tasman Drive will improve connectivity to the Milpitas BART station.

Access to Ed R. Levin County Park is also limited by foot or by bike. Ed R. Levin Park is primarily accessed along Calaveras Boulevard, a high-speed roadway leading east from the city. Although this road is a designated bicycle route (Class III) facility, it is also a designated truck route, requiring bicyclists to navigate with heavy truck traffic in a shared roadway setting. Heading east toward the city limits, the roadway also narrows providing reduced operating space for bicycles. A paved sidewalk is also incomplete along this segment. Opportunities should be explored to better connect Milpitas residents to these regional resources.

Additional trail segments are available along Penitencia Creek and Berryessa Creek. Pathways along both creeks were identified in the previous Trails Master Plan, and while only a few short segments have been built, these trail alignments offer the opportunities to increase low-stress routes connecting residents with schools, shopping, jobs, and public transit. Opportunities to implement these trails and integrate the alignments into a larger network vision for the city should be explored.

Policy and Plan Review

Plan Review

This section provides a brief overview of supporting planning and policy documents relevant to the development of the Bicycle and Pedestrian and Trails plans. The documents reviewed here will be considered both to promote continuity with previous planning efforts and to explore opportunities for further recommendations to grow active transportation networks in Milpitas.

Milpitas General Plan Circulation Element (updated 2010)

The Circulation Element provides support for expanding and enhancing pedestrian and bicycle facilities; improving connections to transit via bicycle and pedestrian routes; and providing end-of-trip facilities and bicycle parking accommodations at community hubs. Further, it identifies the need for a comprehensive network of pedestrian and bicycle facilities that connect all parts of the city. The City is currently updating the General Plan.

City of Milpitas Bikeway Master Plan (2009)

This plan identifies multiple goals to increase bicycle connectivity throughout the city, integrate bicycle facilities into the larger regional trail network, provide roadway safety education to bicyclists and motorists, and encourage bicycling for all ages. Plan recommendations included a series of infrastructure and non-infrastructure improvements including:

- Bicycle wayfinding
- Safe Routes to School and Education Programs
- Improved signals and bicycle detection at intersections

City of Milpitas Trails Master Plan (1997)

The Trails Master Plan recommends an off-street trail network to improve the quality of life for residents by providing an alternative transportation system, expanding recreational opportunities, and preserving and restoring natural environmental conditions of creek corridors that contain trails. It further encourages public involvement by reaching multiple stakeholders to maximize support and ownership of the trails.

Parks and Recreation Master Plan (2008)

The Parks and Recreation Master Plan establishes a vision for a parks and trails system that creates a legacy for future generations, preserves and restores natural resources, improves accessibility to parks, and support an interconnected system of parks and trails that promote social interaction and community health. The plan considers existing resources, maintenance procedures and policies, and implementation of the future vision. The Parks and Recreation Department will be updating this plan in the next year to capture the achievements since the 2008 plan and better reflect the needs of a rapidly growing community.

Streetscape Master Plan

This plan provides recommendations to guide the development and maintenance of public street right-of-way including providing guidelines to improve the pedestrian experience along major streets by incorporating street trees, landscape treatments, and street amenities.

Specific and Area Plans

A number of specific and area plans are in place throughout Milpitas. For example, the Midtown Specific Plan (2002) provides a plan for streetscape improvements along corridors in Midtown, including sidewalk specifications, bike parking requirements, and other improvements that support active transportation. The Transit Area Specific Plan (2011) seeks to guide development of an industrial area into a walkable, transit-oriented district for the new BART station, including specifications around bike parking, public space, and sidewalks.

Regional Plans

Regional plans for the Valley Transportation Authority, Santa Clara County, and Caltrans District 4 also inform the direction this plan. These plans include technical guidance for bikeway development; identify regional facilities, corridor improvements, and spot improvements; and establish consistent approaches for network development and implementation at the regional scale. These plans include various corridor, trail, and subarea studies and the following regional plans:

- VTA Transportation Plan 2040
- Santa Clara County Bicycle Plan
- VTA Bicycle Technical Guidelines
- Caltrans District 4 Bike Plan

Neighboring Jurisdictions

Consistent with the goals of the Santa Clara County Bicycle Master Plan, connected bikeways and shared used pathways across jurisdiction boundaries are imperative to a comprehensive network that connect residential areas, employment, schools, transit, and other destinations. Connectivity should be considered among cities for bicycle facilities, sidewalks, and trails. San Jose to the south and west and Fremont to the north have developed substantial bicycle networks. Recommended facilities in Milpitas should take into consideration proposed facility types in these cities to provide a consistent path of travel. Examples include Warm Springs Boulevard in Fremont and Milpitas. A bicycle lane (Class II) exists today, but Fremont has proposed a separated bikeway (Class IV) to increase comfort of users. Similarly, McCarthy Boulevard, which is currently a shared roadway (Class III), is planned for bicycle lane (Class II) improvement in the future.

Programs Review

Bicycle and pedestrian focused programs provide education and encouragement for residents to use existing bicycle, sidewalk, and trail networks. Programs may include Safe Routes to School, traffic safety campaigns, recreational programs, or similar. As part of this plan, city departments and other partners working on these programs will meet to discuss current efforts and opportunities for expanding education and encouragement efforts within the city. The results of this meeting will be integrated into the final plan documents as part of the Existing Conditions chapter.

Summary

As the City of Milpitas continues to grow and new transportation opportunities are introduced, improved connectivity for bicycles and pedestrians should be explored to provide more transportation options to all residents. Improved bicycle and pedestrian facilities can increase access to recreational opportunities, support trips without a motor vehicle, and support a more vibrant streetscape. Current conditions limit comfortable travel across the city; highways segment the city, creating barriers for continuous travel. Many shared bikeways are co-located with truck routes and along high speed, high volume arterial roadways.

A growing population, an increasing number of jobs, and a variable daytime population may lead to further challenges of congestion, increased safety concerns, and highlight the need for improved access to recreational opportunities.

The following sections of this plan will explore connectivity, access to destinations and recreation, and safety information to guide where network improvements can best support the vision for a comprehensive multi-modal network.

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APPENDIX B

MEMORANDUM

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To: Fanny Yu, City of Milpitas

From: Erin David, Alta Planning + Design

Date: October 28, 2019

Re: Milpitas Bicycle, Pedestrian, and Trails Master Plans Needs Analysis and Gap Summary

Introduction

The following memorandum summarizes the results of the needs analysis and identifies gaps in the existing network. The needs analysis considers network safety, network connectivity, access to destinations, and potential demand for bicycle and pedestrian trips in Milpitas. This information will provide additional insight to the challenges and opportunities for active transportation and will be used to identify network needs and safety improvements across the city. The results of these assessments will inform project recommendations in conjunction with public input.

Safety Analysis

The Safety Analysis considers the locations of bicycle- and pedestrian-involved collisions throughout Milpitas. Using data from the Statewide Integrated Traffic Records System (SWITRS), reported collisions occurring between 2014 and 2018 were considered.

A total of 1,703 collisions were reported during this time period, with bicyclists and pedestrians involved in 11% of all collisions. There were 19 fatalities, over 50% of which were bicyclists or pedestrians. Although reported bicycle- and pedestrian-involved collisions make up a small portion of the total collisions during this time period, the resulting fatalities disproportionately affected these modes.

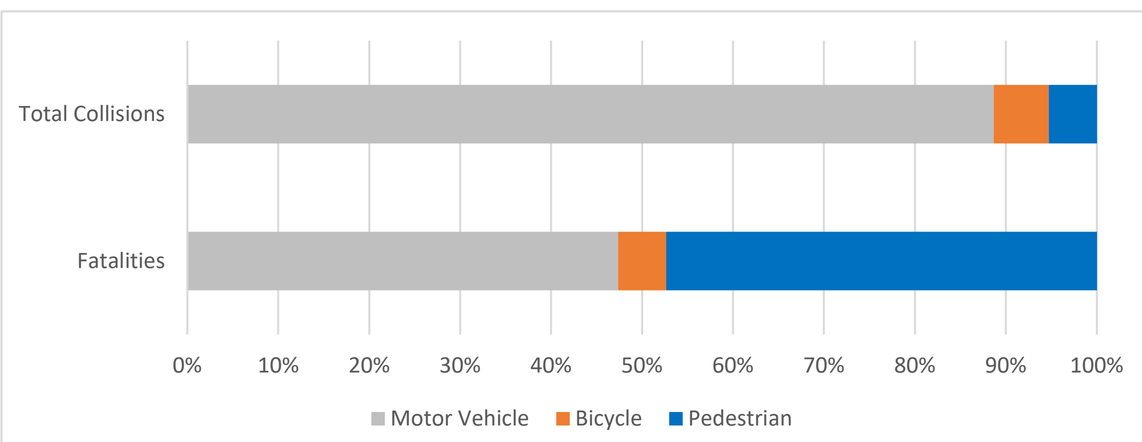

Figure 1: Reported Crashes in Milpitas, 2014-2018

To provide context for these numbers, there were 43 bicycle fatalities and 168 pedestrian fatalities in Santa Clara County during this same time period. This represents nearly 40% of all fatalities. At the county scale, bicycle-involved collisions represented 9.4% of all collisions; pedestrian-involved collisions represented 7.3% of all collisions.

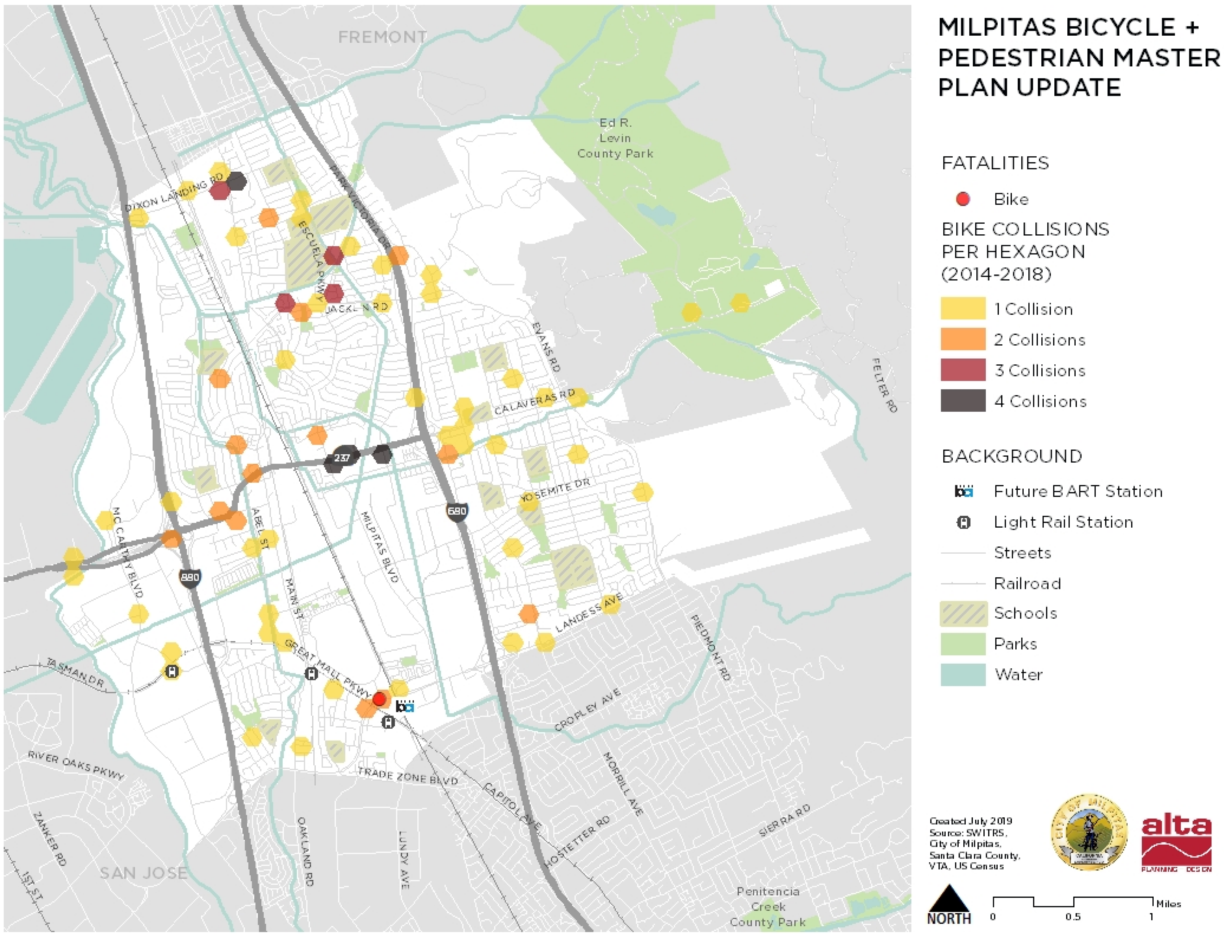

Figure 2: Bicycle Collisions, 2014-2018

From 2014 to 2018, there were a total of 103 bicycle-involved collisions reported in Milpitas, including 8 severe injuries and one fatality. Of the 103 bicycle-involved collisions, 55% occurred at an intersection. As shown in Figure 2 below, bicycle-involved collisions primarily occurred along major roadways, such as Calaveras Boulevard, Montague Expressway, and Jacklin Road. Most of these roadways are either designated bike routes, such as Calaveras Boulevard, or have designated bike lanes, such as Abel Street or Great Mall Parkway. A higher frequency of collisions along these routes suggests that greater separation from motor vehicles through protected bike lanes, shared use pathways, and wider sidewalks is needed.

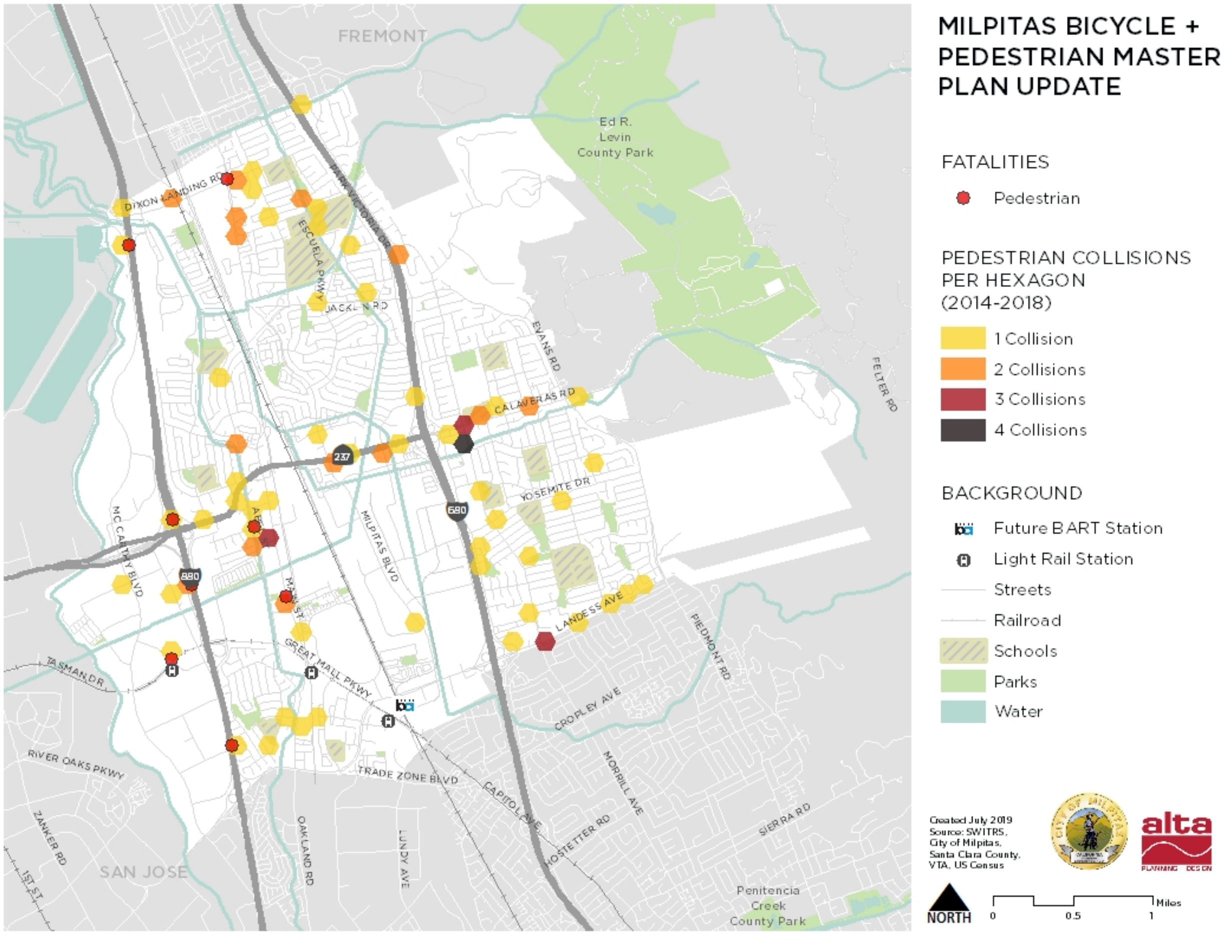

Figure 3: Pedestrian Collisions, 2014-2018

Figure 3 above depicts the pedestrian-involved collisions occurring between 2014 and 2018. Similar to bicycle-involved collisions, pedestrian-involved collisions occurred most frequently along major roadways. Calaveras Road, Landess Avenue, and Dixon Landing Road each had a number of collisions during this time period. These roadways have high posted speeds, more lanes, and also provide a pathway for regional trips; along with business access points and highway ramps, these factors may contribute to the higher frequency of collisions along these roadways. As shown in Figure 1, although pedestrian-involved collisions were fewer than both motor vehicle collisions and bicycle-involved collisions, pedestrian fatalities occurred with similar frequency as compared to motor vehicle collisions during this time period. There were 9 pedestrian fatalities, primarily occurring in the southwest area of the city. There were 17 pedestrian-involved collisions resulting in a severe injury, which represents 24% of all severe injury collisions in Milpitas. The streets with the most pedestrian fatalities and severe injuries were Abel Street and Park Victoria Drive; over 45% of all pedestrian-involved collisions occurred in a crosswalk.

Although there has been a slight decrease in the number of bicycle- and pedestrian-involved crashes during the reporting period analyzed, continued improvements to the network can help improve safety for active modes. Further, the decrease in the number of crashes could be a result of reduced exposure, with fewer people walking and bicycling due to safety concerns. Based on the results of this analysis, both higher speed corridors and crossings of major roadways and highways should be improved to increase separation from motor vehicles for active modes.

Level of Traffic Stress

Level of traffic stress (LTS) refers to the perceived comfort level of a roadway or trail facility for bicyclists and pedestrians. At its foundation, LTS relates to the speed of the roadway, the width of the roadway, and provision of space for bicycles or pedestrians. A roadway with fewer lanes for motor vehicles, lower posted speeds, and greater separation from motor vehicles is considered most comfortable, while high speeds and mixed traffic conditions are least comfortable. A score of LTS 1 is typically considered to be an all ages and abilities facility.

LTS provides insight into network gaps or focus areas for improving the active transportation network. Figure 4 below depicts the LTS scores for roadways within Milpitas. Neighborhood roadways are typically low stress, including the roadways providing connections among neighborhoods. Primary roadways, such as Calaveras Road, Abel Street, Landess Avenue, and Great Mall Parkway, however, are higher stress corridors that not only impact bicycle and pedestrian travel along the roadway, but may also be a barrier for travel across the roadway. When compared to the collision analysis shown in Figure 2 and Figure 3, many of the reported collisions occurred along higher stress roadways; further, higher stress roadways are most prevalent in the areas of the city that include industrial or commercial uses. Given the single-use zoning in these areas, the commercial and industrial areas are built to be primarily accessed by motor vehicles and are located adjacent to major roadways. This land-use pattern does not facilitate safe and comfortable conditions for pedestrians and bicyclists, and alternate routes and improved facilities should be explored.

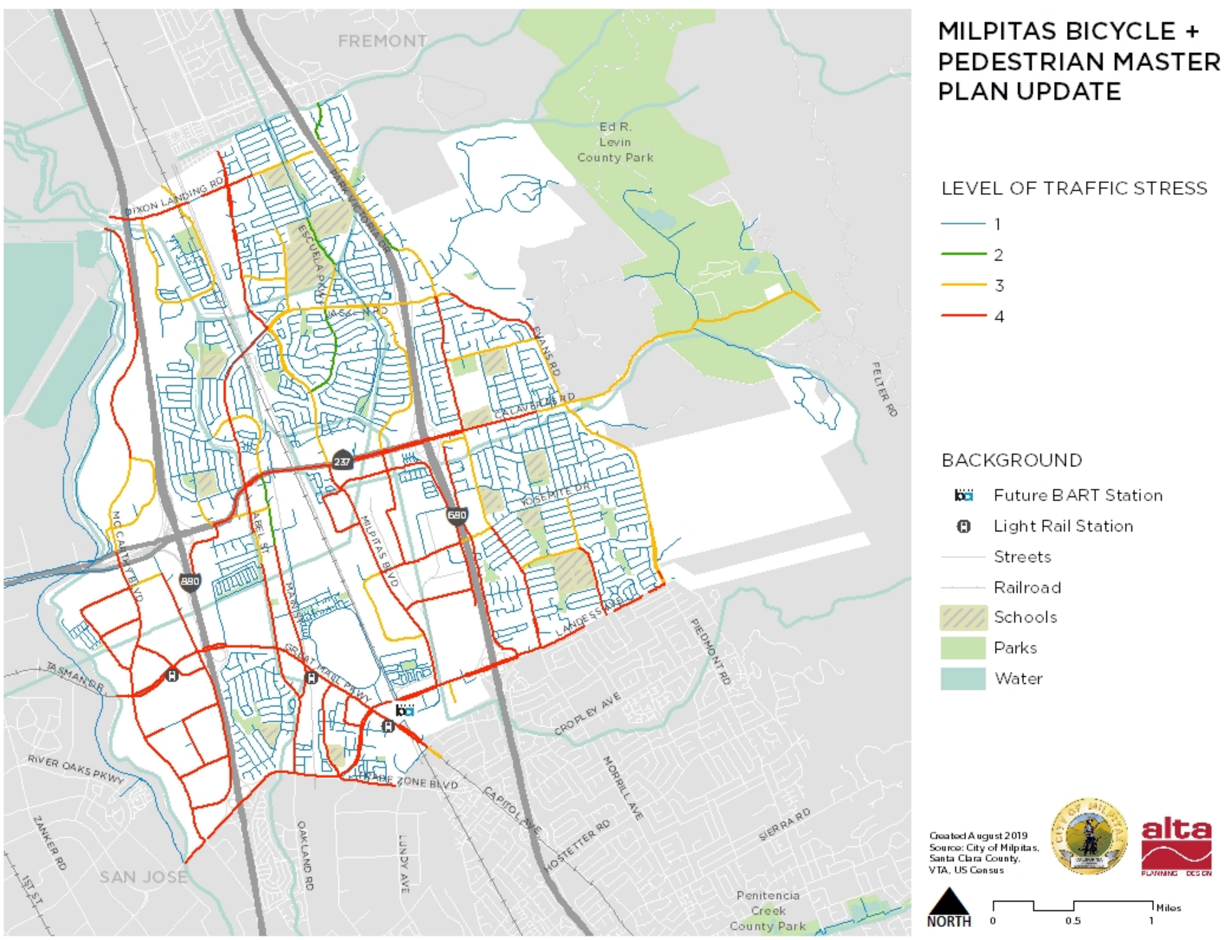

Figure 4: LTS Analysis

Connectivity Analysis

The development pattern in Milpitas includes a high separation of land uses, neighborhoods with cul-de-sacs and limited through-routes, and highways that create barriers for travel throughout the city. These characteristics can lead to longer trip distances and trip times, discouraging trips by bike or by foot. Further, high speed roadways, high volumes of traffic, and infrequent signalized crossings can negatively affect the perceived length of a trip. For many, a walking or bicycling trip in these conditions will feel more difficult and cause a greater degree of discomfort or stress.

To better understand the effects of both real and perceived trip distance, the connectivity analysis assesses bicycle and pedestrian access to destinations throughout Milpitas. Travel along higher stress roadways is weighted to reflect longer perceived travel times in order to more accurately represent the experience of residents. The results of this analysis demonstrate the distance to the nearest destination—whether that is a school, a park, or a transit station—from any given roadway intersection.

The maps that follow seek to identify opportunities to improve access to destinations through increased connectivity, improved route directness, and new low stress bikeways and pedestrian pathways. Results are displayed based on distance and correspond to average walking or bicycling times. For example, a one-half mile walk will take an average resident approximately 10 minutes to complete, while a 10-minute bike ride will typically cover around one-and-a-half miles. With many trips across the United States covering distances of 3 miles or less, these thresholds can help us understand where switching trips to an active mode may be more viable with improved networks.

Access to Schools

Within most residential areas, a public school is accessible within a one-mile walk or less. As shown in Figure 5 below, residential areas to the east of I-680 and immediately west of I-680 in the northern extent of the city have greatest access, with most areas providing walking access to a school within ½ mile or less, or approximately a 10-minute walk. However, neighborhoods to the east of I-880 and west of the railroad have more limited access to schools. The two schools located in these neighborhoods are both elementary schools; for access to the middle school or high school in this part of the city, longer trips that require navigating higher stress roadways across the railroad are required. A more comprehensive understanding of providing safer routes to school should consider access by grade level and seek to better connect neighborhoods to schools across all grades.

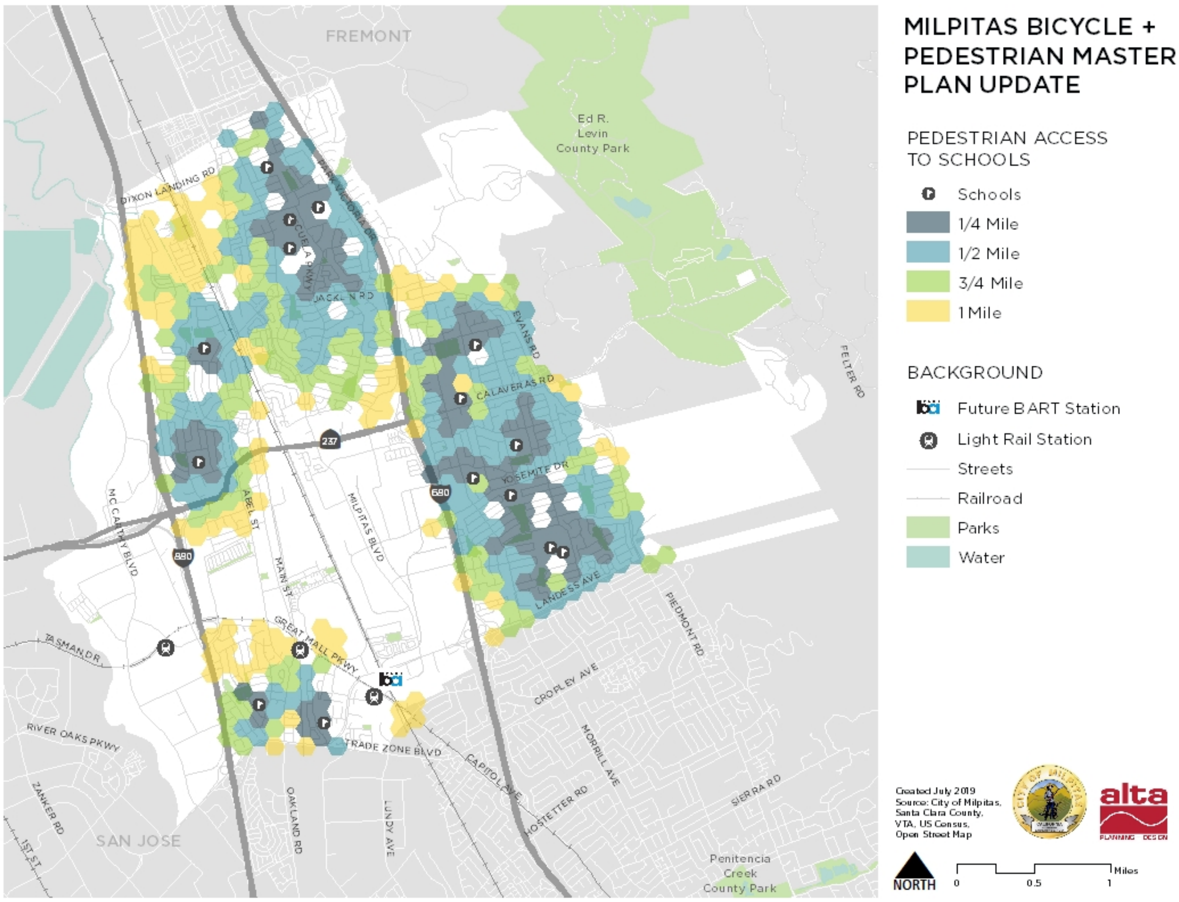

Figure 5: Pedestrian Access to Schools

A 10-minute trip to school by bicycle increases the range of accessibility for students travelling from neighborhoods to elementary, middle, and high schools. For students who are able to bike to school, a greater number of schools, including middle and high schools, are accessible across more neighborhoods. In fact, very few areas are outside of a 10-minute bike ride (approximately 1.5 miles) from the nearest school, and nearly all residential areas within the city fall within the two-mile threshold for bicycle access. Although there is high access to schools, further consideration of low stress, continuous routes to school should be considered. In addition to providing safe, separated pathways for students to travel to school, it is also important to consider access to schools of all grade levels and providing high quality routes that connect neighborhoods.

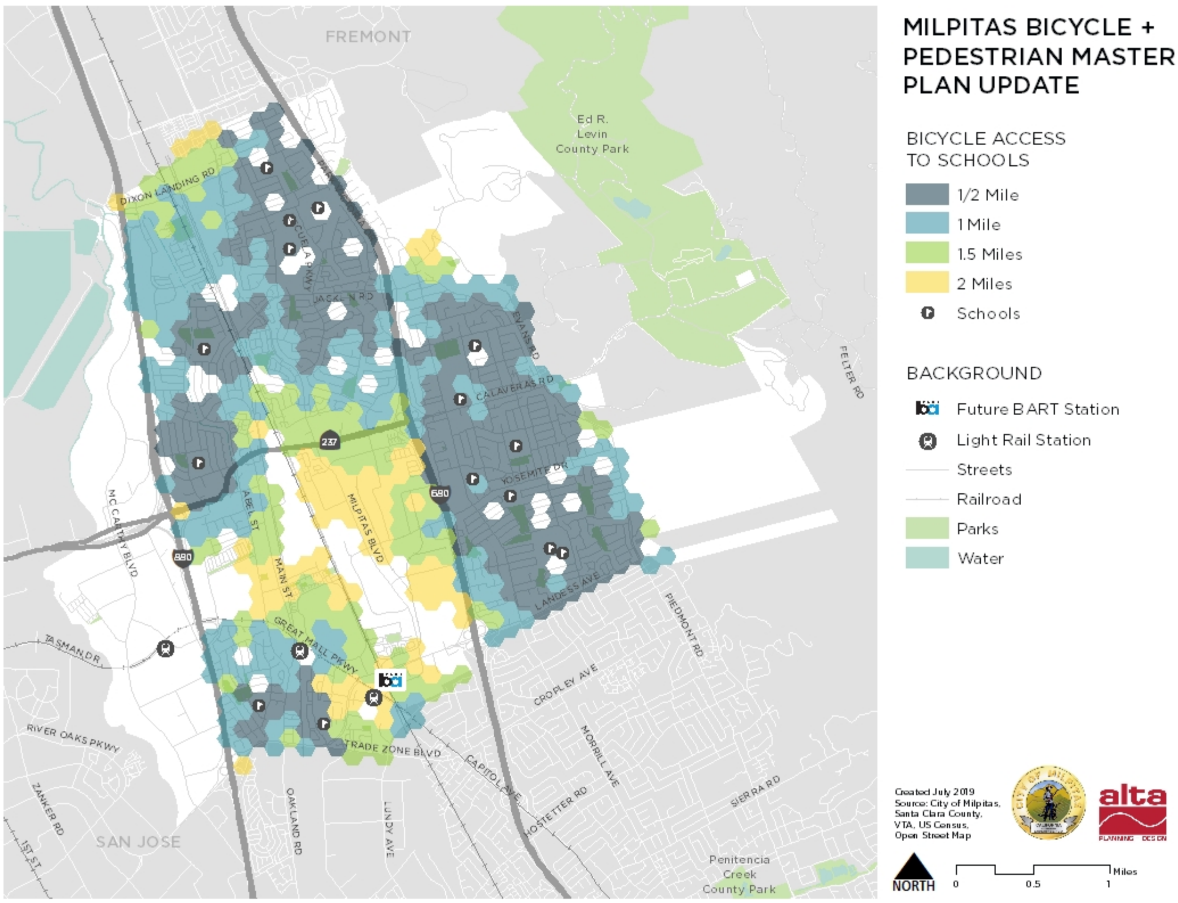

Figure 6: Bicycle Access to Schools

Access to Transit

Transit access is considered in two parts. First, access to light rail and BART are considered; then frequent service bus routes as defined by VTA are assessed. By considering these modes separately, opportunities to connect residents and employers to regional routes, such as light rail and BART, are more apparent.

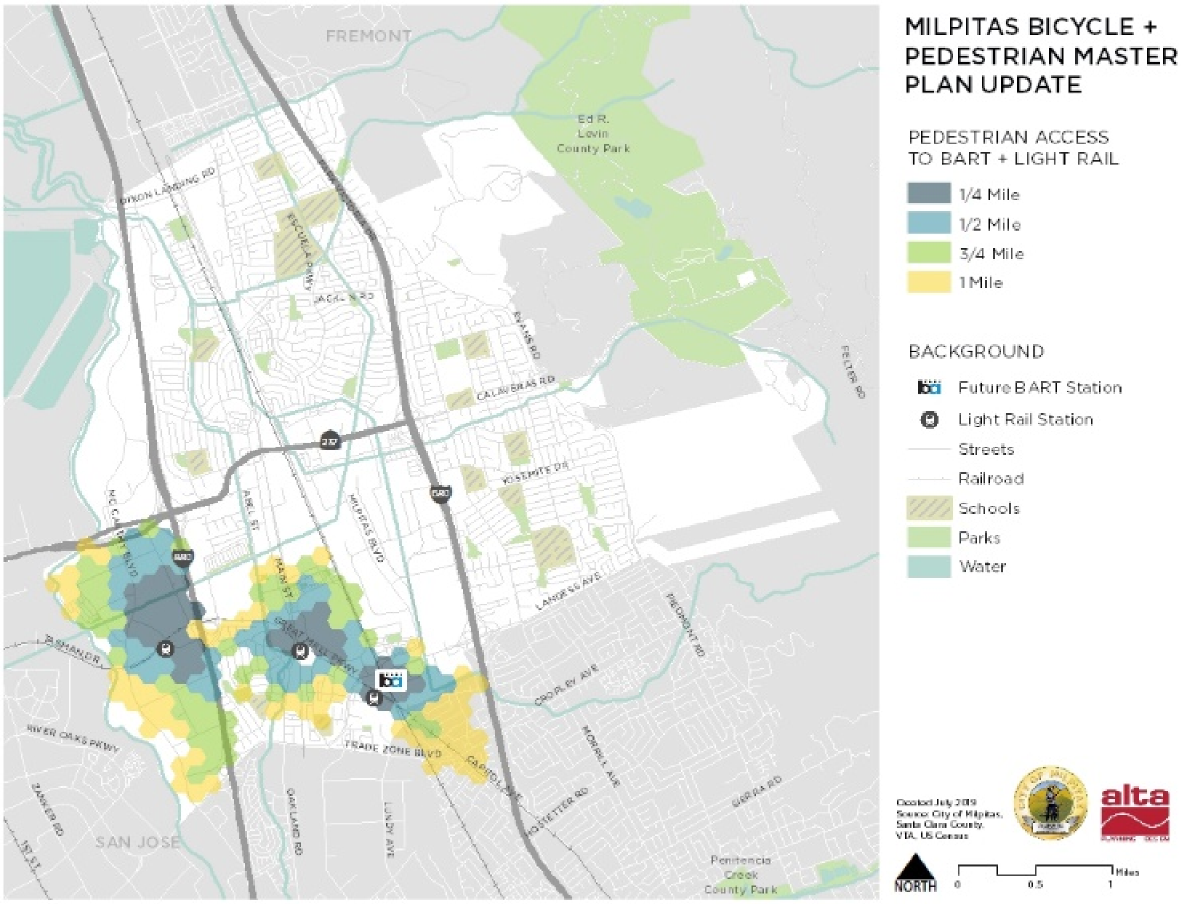

Figure 7: Pedestrian Access to BART and Light Rail

Access to light rail and BART is concentrated in the southern portion of the city nearest the station locations for both walking and bicycling. Pedestrian access, as shown in Figure 7 above, is limited to within a few blocks of the station locations, which serve only a small number of residential and commercial areas in the city. While this provides connections to several major employers, pedestrians must travel along higher speed corridors and through indirect routes. Further, these trips will best serve those who are traveling from further away to work in Milpitas, while access for residents to reach other regional destinations is limited. While land use patterns limit transit access for residents living in the northern areas of the city, opportunities for safer and more direct routes to stations can expand pedestrian access and should be explored.

Figure 8 below demonstrates that access to the station is improved when bicycling, with a larger area available within a 10-to-15-minute bike ride. While areas of accessibility are increased with bicycling, access is primarily concentrated within industrial areas of the city. Crossings of highways and major roadways, along with a less-dense roadway network, affect direct accessibility to the station; opportunities to improve low stress routing or implement more direct routes, such as through a new trail, should be considered.

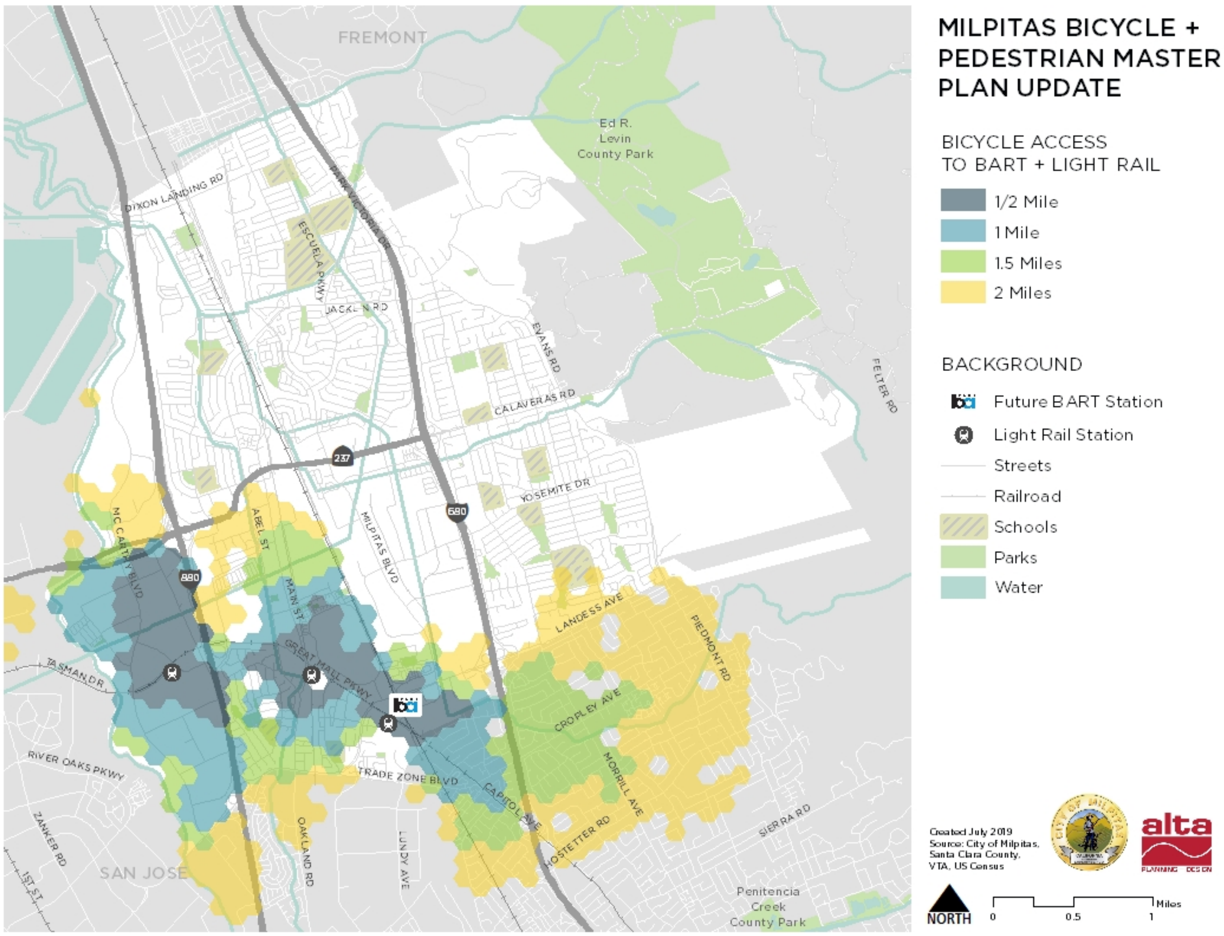

Figure 8: Bicycle Access to BART and Light Rail

Expanding this assessment to include high-frequency buses, more of the city has access to transit within a short walk or bike ride. Access to frequent bus routes by foot, as shown in Figure 9, is primarily concentrated in the central area of the city between I-880 and I-680. Nearly all locations within this area and north of Highway 237 are within one mile or less of a frequent bus route. However, these results demonstrate clearly the impact of cul-de-sacs and indirect roadway networks. Walking trips to transit quickly rise to one-half mile or more, despite straight-line distances to the nearest bus stop measuring less than one-quarter mile. Out-of-direction travel required due to limited access points and dead-end roadways significantly limits pedestrian access to transit.

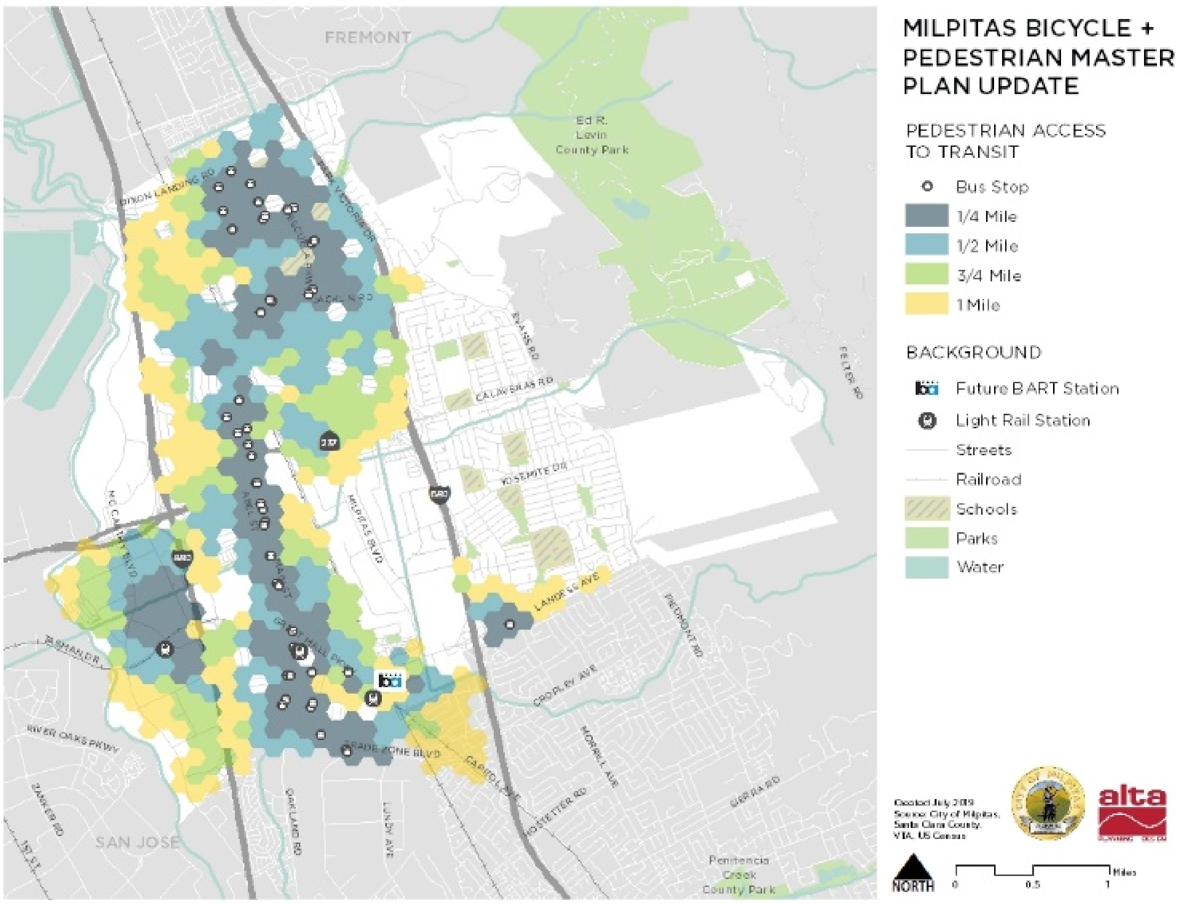

Figure 9: Pedestrian Access to Transit

Bicycle access to frequent bus routes is generally constrained by I-880 and I-680, similar to pedestrian access. However, most locations within this area are within a one-mile bike ride to a frequent bus route. Areas with more limited access are located either east of I-680, west of I-880, or along the large commercial parcels in the northeast of the future BART station. Figure 10 on the next page depicts bicycle access to frequent transit routes. Bicycle access can be improved through increasing separation from motor vehicles and identifying additional low-stress routes and crossings.

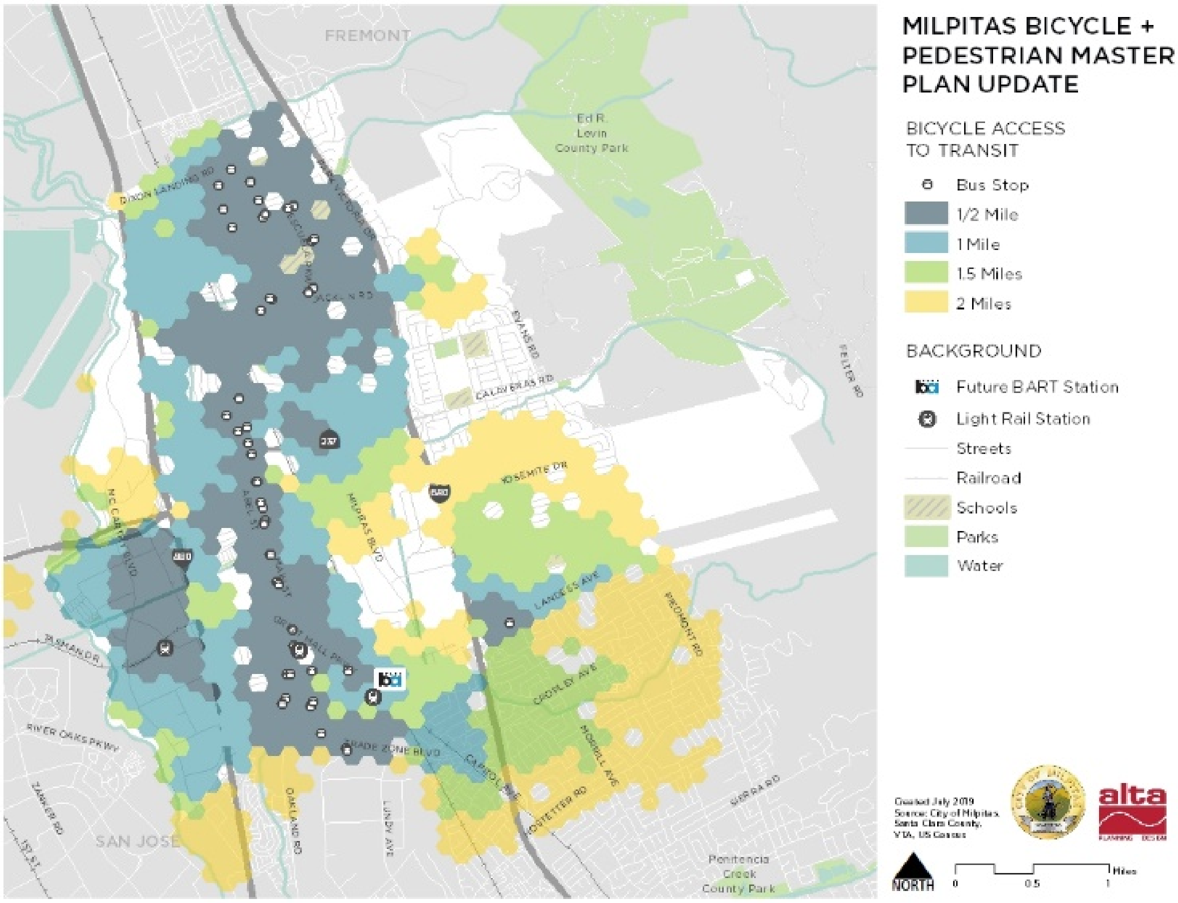

Figure 10: Bicycle Access to Transit

For residents who want to use BART to reach destinations outside of Milpitas, bus connections to the station can facilitate car-free trips to reduce congestion and provide access for those without motor vehicle access. However, few frequent bus routes and land use patterns that require a sizable walk to the bus stop may discourage potential transit users. Opportunities to connect street ends and improve wayfinding and routing to high frequency bus stops will facilitate more multimodal trips. Bicycle routes that provide greater access to high frequency bus routes should be prioritized to encourage seamless transitions among modes and increase access to transit opportunities in the region.

Access to Parks

Access to parks and recreational space is prevalent throughout the city. Nearly all residential areas within the city are within one-half mile or less of a park entry point. If the threshold is increased to one mile, even more of the city is within easy reach of a park. In many areas, walls, fencing, or other barriers restrict access to parks at specific points. Even with this in mind, access to parks across the city is high. The areas with limited access to a park are primarily confined to the central area of the city, where land uses are predominantly industrial and commercial. Improvements that support access to parks and recreational opportunities should consider the comfort level of the trip to the park and opportunities to improve access to regional destinations. Other considerations, such as wayfinding, can help residents navigate to their nearest park.

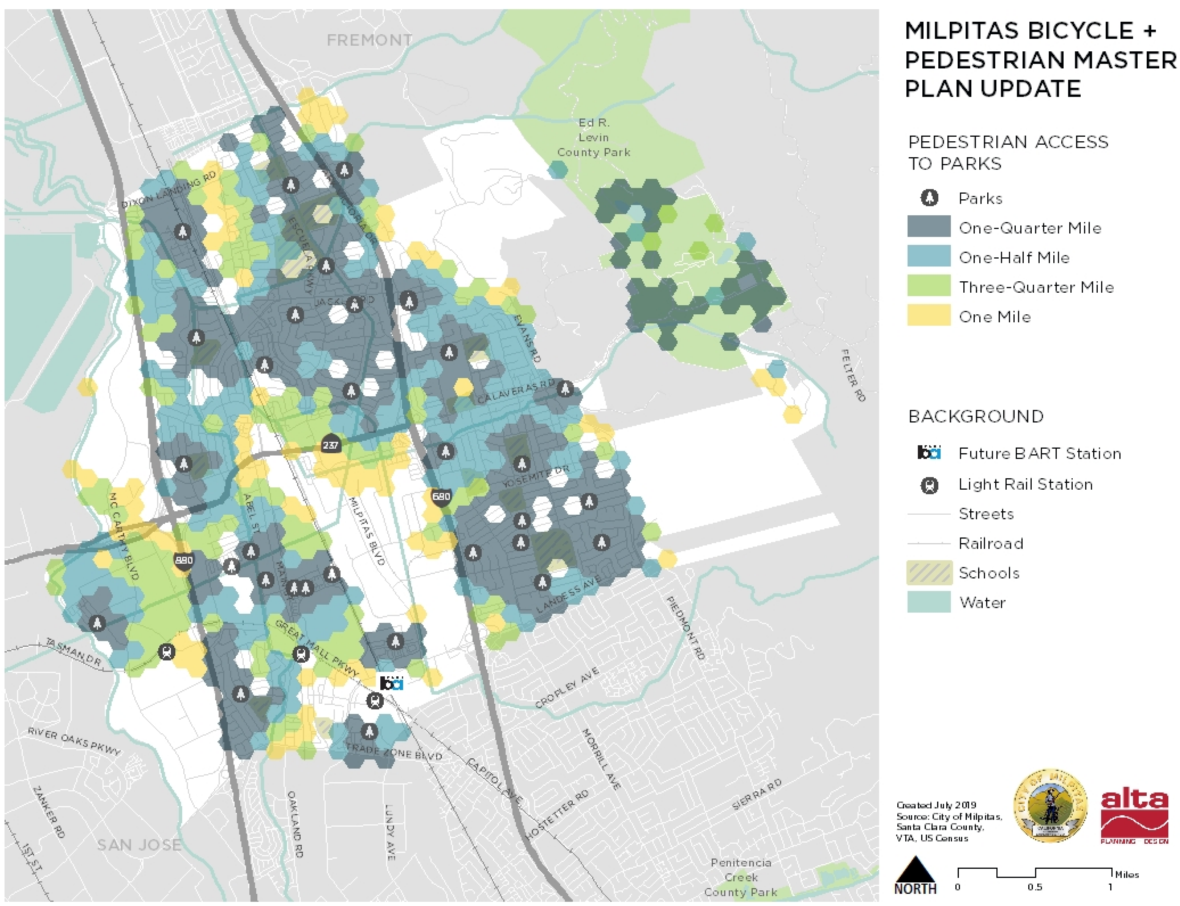

Figure 11: Pedestrian Access to Parks

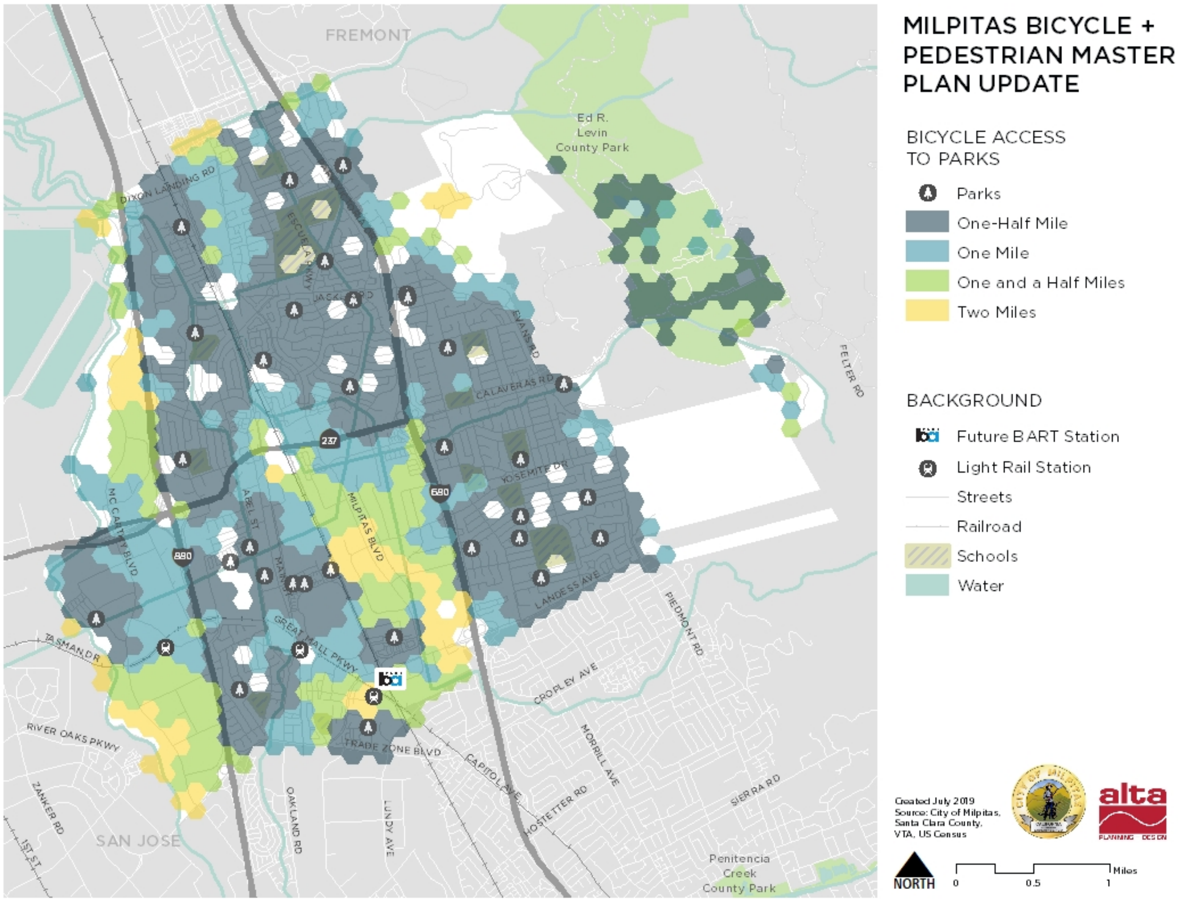

Figure 12: Bicycle Access to Parks

Bicycle access to parks is even greater than by foot, with only a few areas in the city being greater than one-mile travel distance from a park; nearly all of the city is within two miles of a park. Where access is most limited, larger parcels, less dense roadway networks, and less frequent intersections lead to longer trip distances. Increased access points across these parcels can significantly improve access to open space within the city.

Connections to Neighboring Jurisdictions and Recreation

Consistent with the vision for a regional bicycle network, it is important to consider the connections between Milpitas and its neighboring cities. Several existing facilities provide continuous connections into the neighboring jurisdictions of Fremont and San Jose. For example, an existing bike lane (Class II) along Milpitas Boulevard continues north of Milpitas city boundaries and into Fremont. Similarly, bike lanes along Great Mall Parkway and Oakland Road connect across city boundaries into San Jose.

However, there are several locations where recommended bike facilities should consider improving connections to neighboring jurisdictions. Depicted in Figure 13 below, these opportunities include:

- Completing connections into San Jose and to the Coyote Creek Trail near the Montague Expressway, connecting to existing bikeways on Trimble Road and Junction Avenue.
- Completing connections between McCandless Drive in Milpitas and Ringwood Avenue in San Jose to support access to the BART station and provide an additional point of connection between the two cities
- Considering opportunities to improve connections into Fremont both from east of I-680 and by way of low-stress facilities, such as the Hetch Hetchy Trail.

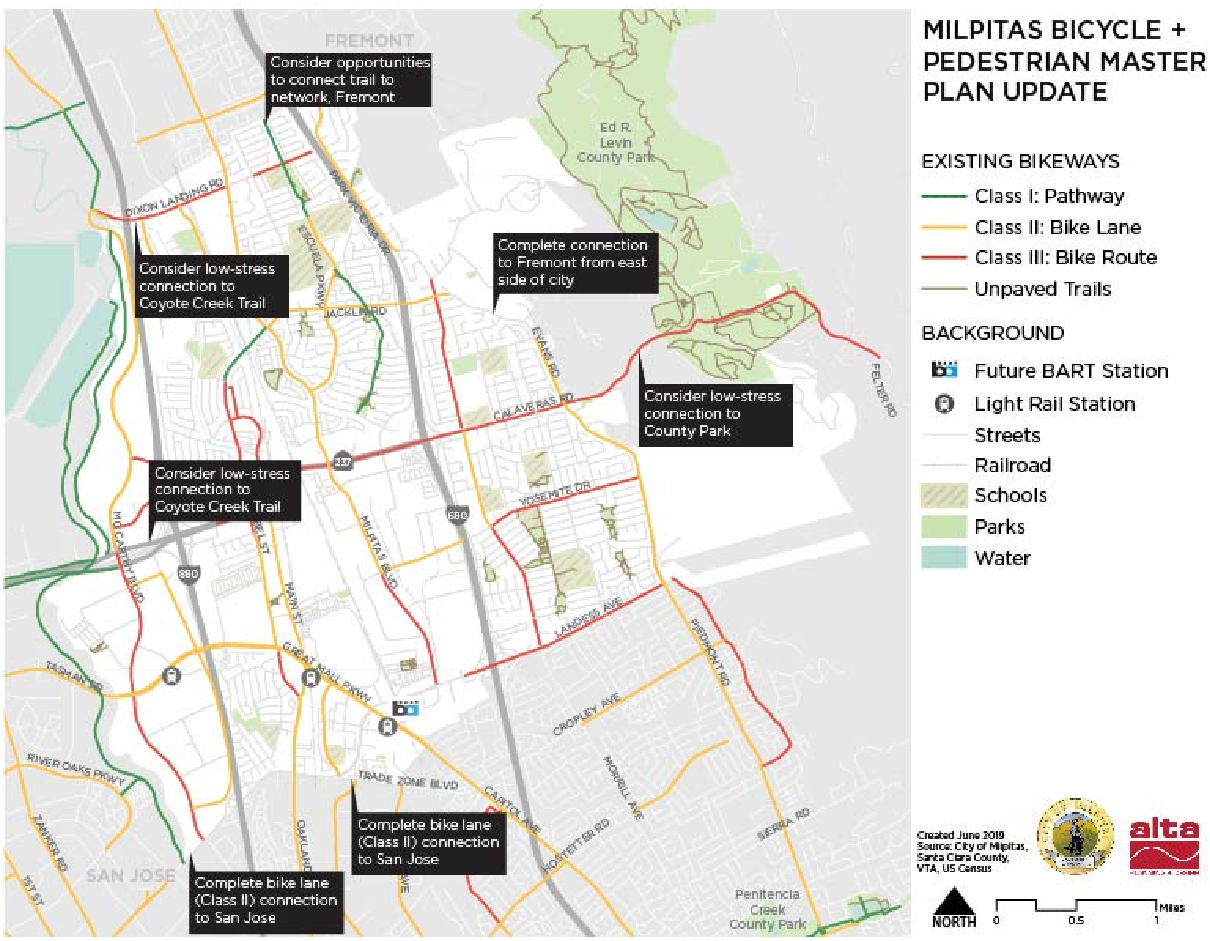

Figure 13: Connections to Neighboring Jurisdictions + Recreation

A regional network will also include connections to regional recreation opportunities and regional trail facilities, such as the San Francisco Bay Trail. As shown in Figure 13, connections to Ed R. Levin County Park and improved low-stress routes to Coyote Creek Trail can increase access for Milpitas residents.

Demand Analysis

The Demand Analysis assesses potential existing and future demand for walking and bicycling trips based on regional trip data available from the Metropolitan Transportation Commission (MTC). The MTC is responsible for transportation planning and related tasks for the nine-county San Francisco Bay Area, including Milpitas. They seek to understand transportation needs based on projected future conditions and population growth. Using this data, the demand analysis identifies areas in the city with large numbers of short trips (under 3 miles); trips in this range are most viable to switch to active modes, like walking and bicycling.

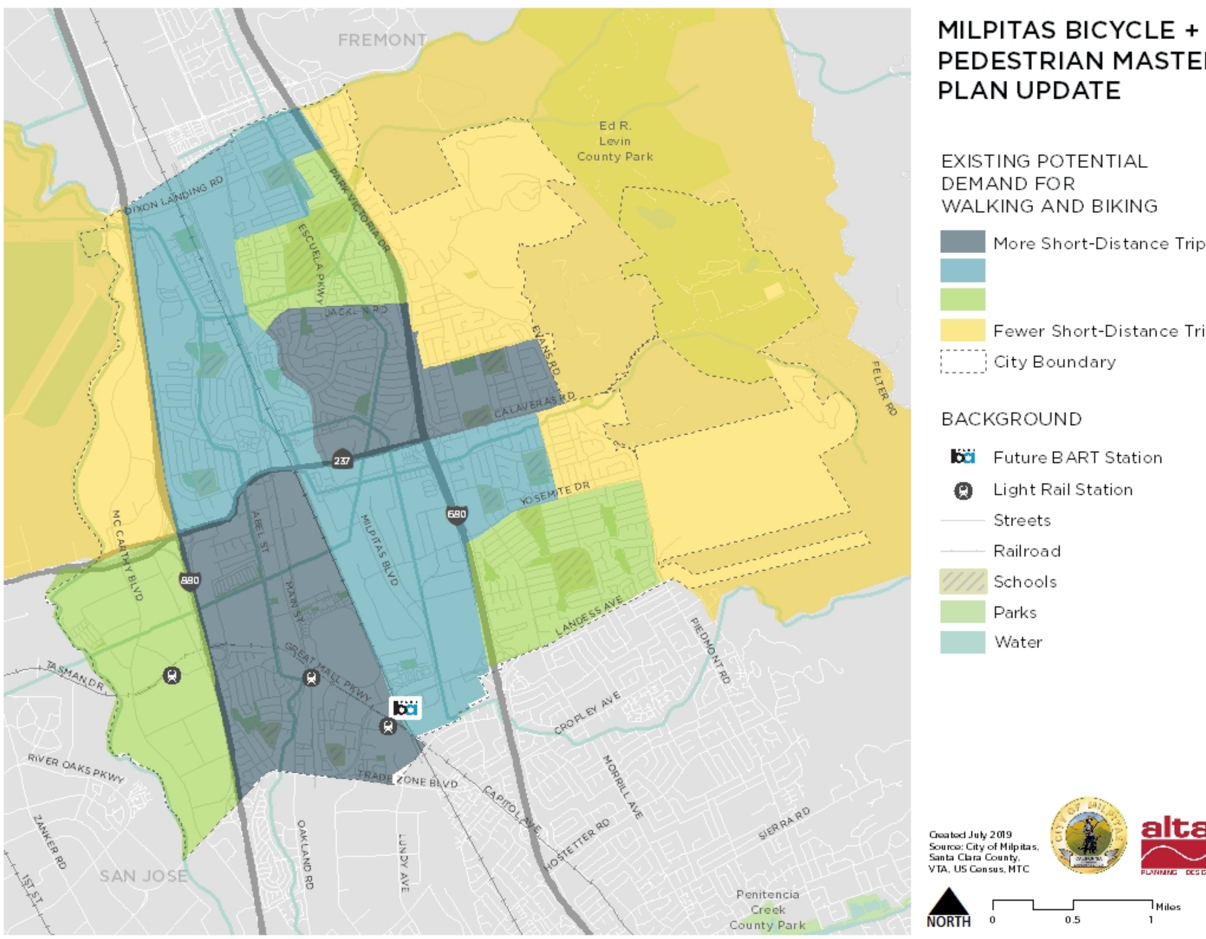

Figure 14: Existing Potential Demand for Walking and Biking Trips

Data is aggregated to Transportation Analysis Zone boundaries, which are the standard unit for transportation planning used by the MTC. Existing conditions represent 2015 trip conditions. Shown in Figure 14 above, the greatest number of shorter-distance trips are taking place in the south and central areas of Milpitas, while the furthest corners of the city have fewer short-distance trips.

In addition to understanding where facilities may help meet current unmet demand for walking and biking, understanding where short trips are anticipated to grow in number can help direct bicycle and pedestrian investments. In the map below (Figure 15), the estimated density of short trips for 2040 was compared to 2015 data. Areas nearest the light rail and BART stations are expected to see the greatest growth in short trips, likely due to transit-oriented development and improved connectivity, while the area east of I-680 along Calaveras Road is expected to see a reduction in short trips. This is likely due to the anticipated development patterns in this area and anticipated needs of this area, such as potentially reduced trips to schools or employment locations being further away. Further, it is important to note that TAZ boundaries are not coincident with city or growth area boundaries and may include areas of land that are not planned for future development. Changes in demand over time may be due to limited areas within a larger TAZ or anticipated shifts in travel patterns based on population characteristics. Overall, improved facilities and new connections can encourage more trips by active modes, particularly where there are connections to transit.

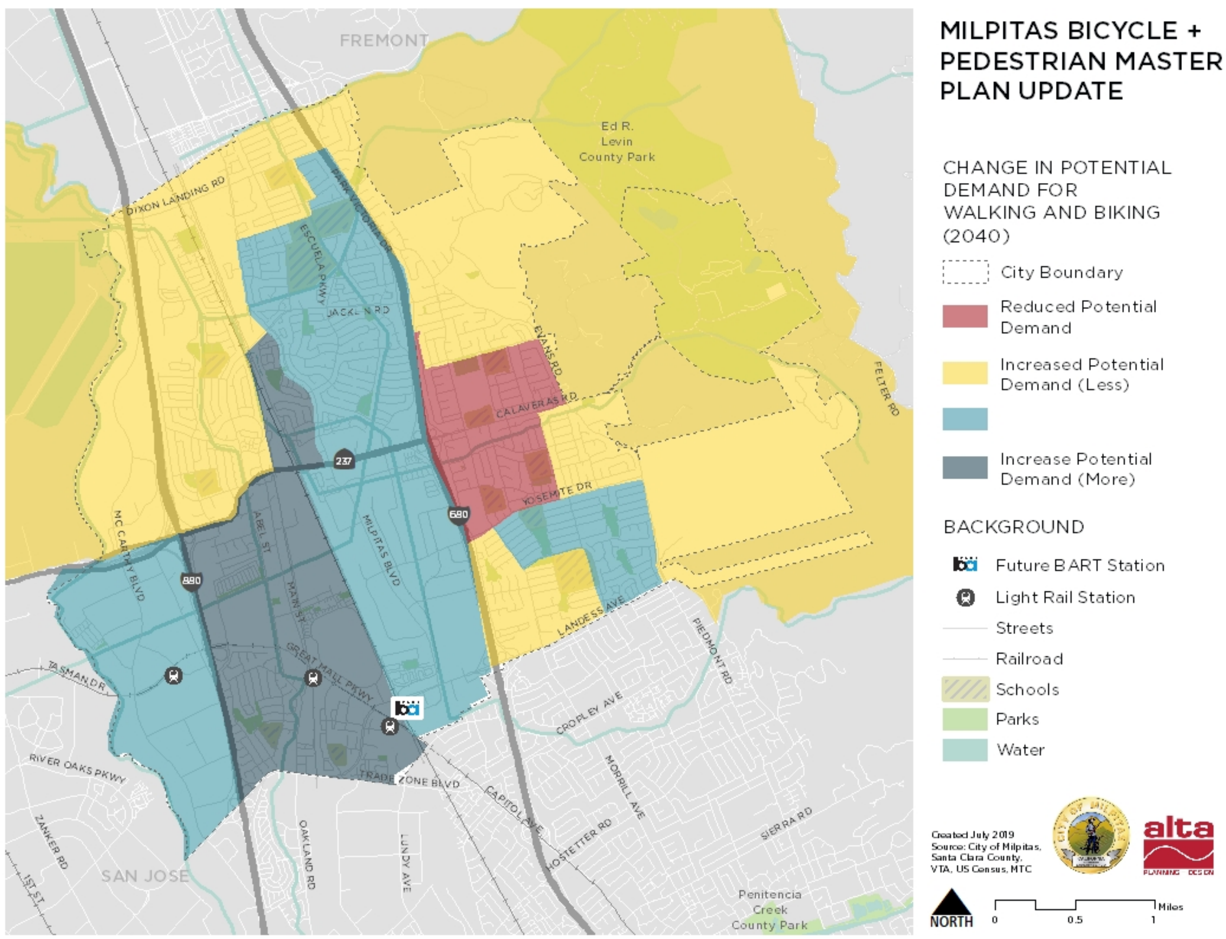

Figure 15: Change in Potential Demand for Walking and Bicycling Trips (2040)

The results of the demand analysis demonstrate the importance of providing high quality pedestrian and bicycle connections to transit. Trips to and from the Milpitas BART station are expected to increase after station opening. With investment in the Tasman Street/Great Mall Parkway Corridor seeking to improve bicycle and pedestrian connectivity to the station, Milpitas should seek to enhance connections in the areas beyond the immediate station area. By encouraging more trips by bike or by foot, the city has the opportunity to reduce congestion, improve quality of life, and provide more mobility options for all.

Summary

The results of the needs analysis suggest several key opportunities for identifying gaps and potential projects throughout Milpitas. Projects that provide greater separation from motor vehicles, particularly on high speed corridors, will contribute to greater connectivity and improved safety across the city. Focus should be given to routes that connect to schools, provide access across highways and other major roadways, connect to high frequency transit, and increase access to regional recreational opportunities. With increased demand for trips near light rail and BART stations, opportunities should also be explored to further improve resident access to these regional transit systems. Potential locations for new trails, which will be further informed by public input, should connect to other recreational opportunities as well as to the rest of the bicycle network. Recommendations should also consider opportunities for new or improved trailheads and associated amenities, such as end-of-trip facilities like bike storage.

The map below (Figure 16) summarizes the findings of the needs analysis and includes opportunities to improve the active transportation network in Milpitas. These opportunities are shown, building on the LTS analysis, to demonstrate the existing network gaps in a city-wide low-stress network. The findings explored in this memo will be combined with public input to develop recommendations for an improved bicycle, pedestrian, and trail network.

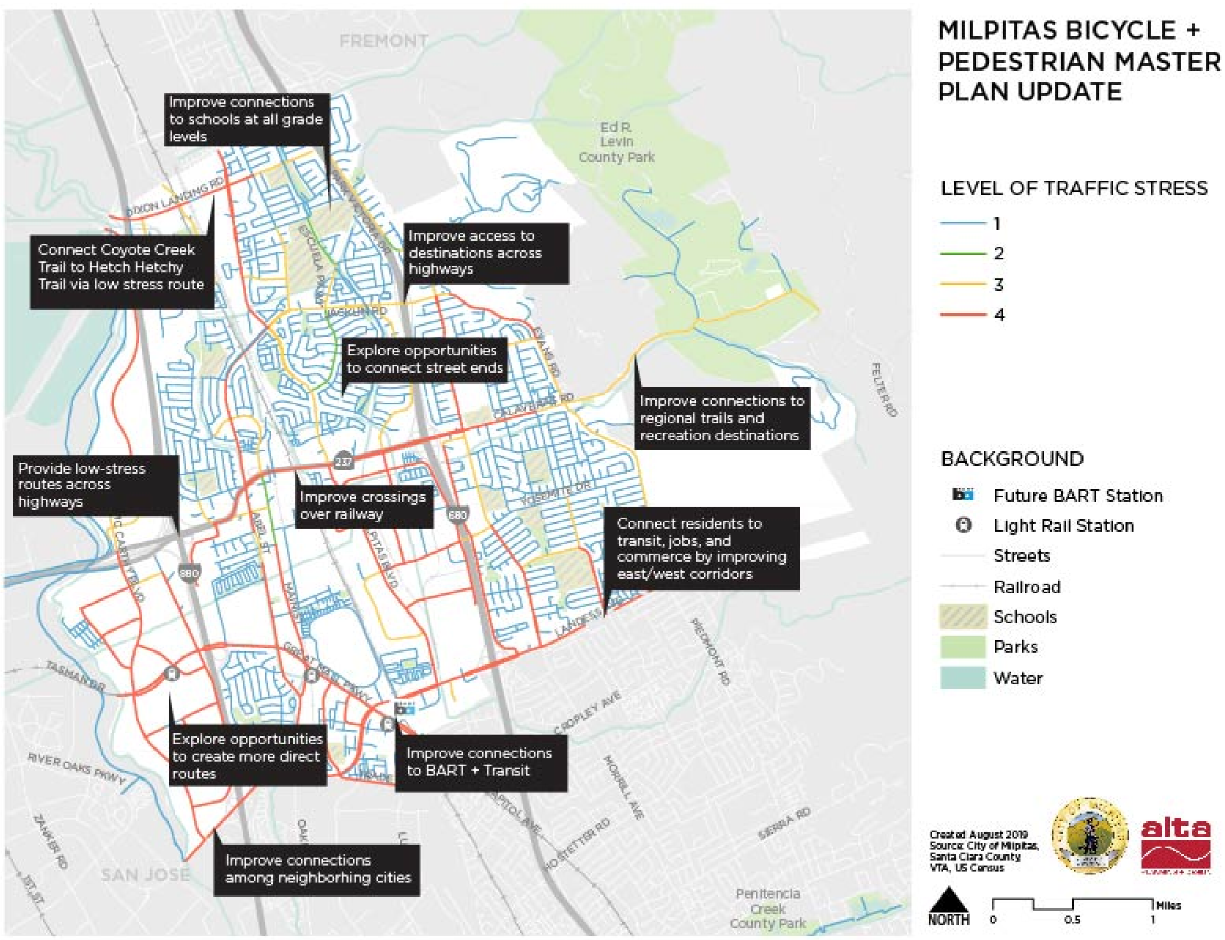

Figure 16: Needs Analysis Summary

APPENDIX C

MEMORANDUM

304 12th Street, Suite 2A
Oakland, CA 94607
(510) 540-5008
www.altaplanning.com

To: Fanny Yu, City of Milpitas

From: Erin David, Alta Planning + Design

Date: May 06, 2020

Re: Milpitas Bicycle and Pedestrian Master Plan Update and Trails Master Plan Update: Proposed Prioritization Strategy DRAFT

Introductions

The following memorandum outlines the proposed prioritization strategy for implementation of the Bicycle and Pedestrian Master Plan Update and Trail Master Plan Update. This approach is intended to establish a framework that can be used to revisit prioritization as needed to account for future changes in priority as Milpitas continues to grow.

Strategy

Through this evaluation process, projects will be grouped into four Project Categories that represent varying phases and/or approaches to project implementation. These categories will be based on project priority and relative project feasibility. Each project will be evaluated as "high" or "low" on each axis, resulting in the four Categories, depicted in Figure 1 (right).

These four categories can be summarized as follows:

- Short term priority projects are rated high priority and high project feasibility
- Long term priority projects are rated high priority and low project feasibility

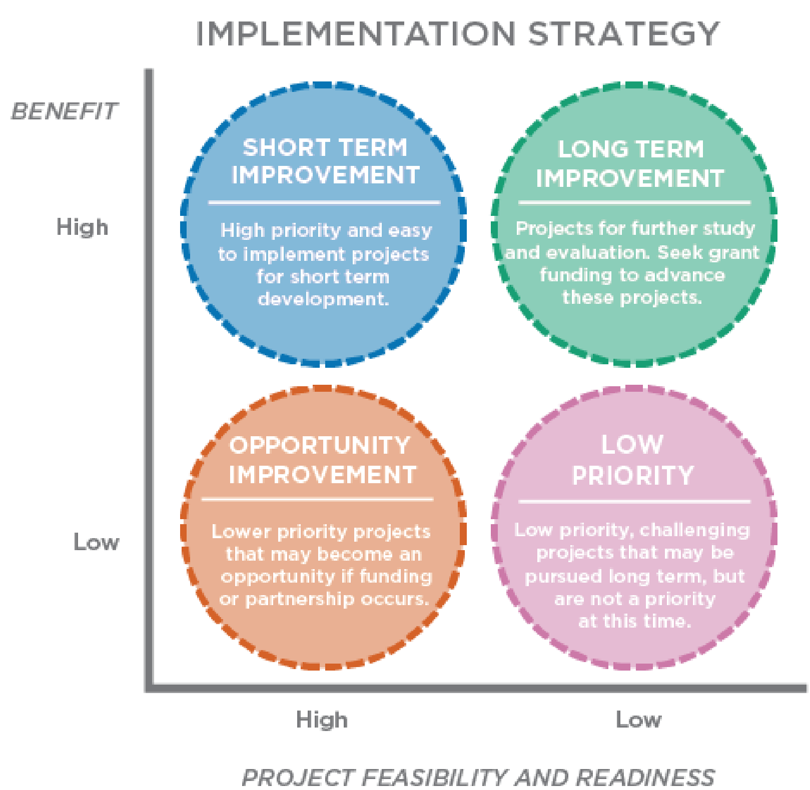

Figure 1: Implementation Strategy Categories

- Opportunity projects are rated low priority and high project feasibility
- Low priority projects are rated low priority and low project feasibility

Bike Network Evaluation Criteria

In order to sort projects into these four overarching categories, a series of criteria will be used to evaluate projects in relation to plan goals and public engagement findings. Table 1 on the next page outlines the details of these criteria. In general, projects benefit or priority will be evaluated based on:

- Connectivity: Does the project provide access to parks, trails, transit, schools, employment centers, or commercial centers?
- Gap Closure: Does the project close the gap between two existing facilities? This criterion will also consider neighboring jurisdiction existing and programmed facilities.
- Safety: Does the project improve conditions along a corridor or at an intersection that has a history of collisions? Does the project improve the quality of a high stress segment link?
- Project Support: Has the project been identified in previous planning efforts or was it identified through the public engagement process?

Table 1: Bicycle Network Proposed Evaluation Criteria - Priority

CATEGORY	CRITERIA	DESCRIPTION	SCORING
CONNECTIVITY	Connectivity to Transit or Schools	Project provides connections to transit, including local bus, BART, and light rail; or project provides connections to schools. Project should be located within ¼ mile of transit or schools to qualify.	Project receives full points if within ¼ mile of school, BART, light rail, or high frequency bus stop.
	Connectivity to Parks or Trails	Project provides connections to trails or parks. Project should be located within ¼ mile of a trailhead or park to qualify.	Project receives full points if within ¼ mile of trailhead or park.
	Connectivity to Employment Centers or Services	Project provides connections to employment or commercial centers. Project should be located within ¼ mile to qualify.	Project receives full points if within ¼ mile of commercial, industrial, or Town Center zoning.
GAP CLOSURE	Gap Closure	Project closes existing network gap between two existing facilities, or across a challenging crossing. Gap closure should consider neighboring jurisdiction's existing and proposed networks.	Project receives full points if it connects on both ends to an existing facility. Project receives partial points if it connects to an existing facility on one end only.
SAFETY	Previous Collision	Project provides safety improvement near reported crash location. Collision occurred at the project intersection or along the identified project segment.	Project receives full points if a severe injury or fatal collision occurred along the project segment. Project receives partial points if a collision occurred along project segment.
	Level of Traffic Stress	Project improves a high stress roadway (LTS 3 or 4 network link)	Project receives full points if it improves an LTS 4 roadways. Project receives partial points if it improves an LTS 3 roadway.

CATEGORY	CRITERIA	DESCRIPTION	SCORING
PROJECT SUPPORT	Public Support	Project was supported by the public through this Plan's public engagement activities	Project receives full points if it was identified in Phase 1 Public Outreach.
	Previous Plan	Project identified in previous planning efforts.	Project receives full points if it was identified in a previous planning effort.

To evaluate project feasibility, criteria will consider:

- **Project Complexity:** Does the project require significant reconfiguration of the roadway, right-of-way (ROW) acquisition, or similar?
- **Agency Collaboration:** Will the project require collaboration with one or more agencies, such as VTA, Valley Water, or neighboring jurisdictions?

These criteria are outlined in Table 2 below. For feasibility, it is assumed that if a project meets at least one of these criteria, it is considered low feasibility. In the project tables that follow, please note that a score of 1 is considered low feasibility; a maximum score of 1 is currently considered for feasibility.

Table 2: Bicycle Network Proposed Evaluation Criteria - Feasibility

CATEGORY	DESCRIPTION
Agency Coordination	Requires coordination among multiple agencies (CalTrans, VTA, etc.)
Project Complexity	Project requires significant roadway reconfiguration or ROW acquisition.

Trail Network Evaluation Criteria

The trail network will be prioritized separately, with the final prioritized project list for all Class I and shared use pathways featured in the Trail Master Plan Update. These segments will not be included in the Bicycle Master Plan Update project list.

The prioritization approach for the trail network will build on the criteria outlined for the bicycle network in the above sections. Table 3 that follows outlines the details of these criteria. In general, project benefit or priority will be evaluated based on:

- **Connectivity:** Does the project provide access to parks, transit, schools, employment centers, or commercial centers?

- **Gap Closure:** Does the project close the gap between two existing facilities? Does the project extend an existing facility? This criterion will also consider neighboring jurisdiction existing and programmed facilities.
- **Safety**: Does the project provide an alternate route along a corridor with a history of collisions?
- **Project Support:** Was the project identified by the public as a needed improvement?

Table 3: Trail Network Proposed Evaluation Criteria - Priority

CATEGORY	CRITERIA	DESCRIPTION	SCORING
CONNECTIVITY	Connectivity to Transit or Schools	Project provides connections to transit, including local bus, BART, and light rail; or project provides connections to schools. Project should be located within ¼ mile of transit or schools to qualify.	Project receives full points if within ¼ mile of school, BART, light rail, or bus stop.
	Connectivity to Parks or Trails	Project provides connections to parks. Project should be located within ¼ mile of a park to qualify.	Project receives full points if within ¼ mile of a park.
	Connectivity to Employment Centers or Services	Project provides connections to employment or commercial centers. Project should be located within ¼ mile to qualify.	Project receives full points if within ¼ mile of commercial, industrial, or Town Center zoning.
GAP CLOSURE	Gap Closure	Project closes existing network gap between two existing facilities, or across a challenging crossing. Gap closure should consider neighboring jurisdiction's existing and proposed networks.	Project receives full points if it connects on both ends to an existing facility. Project receives partial points if it connects to an existing facility on one end only.
SAFETY	Previous Collision	Project provides safety improvement and/or alternate routing near reported crash location.	Project receives full points if a severe injury or fatal collision occurred along an adjacent roadway. Project receives partial points if a collision occurred along an adjacent roadway.

CATEGORY	CRITERIA	DESCRIPTION	SCORING
PROJECT SUPPORT	Public Support	Project was supported by the public through this Plan's public engagement activities	Project receives full points if it was identified in Phase 1 Public Outreach.

To evaluate project feasibility, criteria will consider:

- **Project Complexity:** Does the project require significant reconfiguration of the roadway, right-of-way (ROW) acquisition, or include significant construction to address existing barriers?

For Trail Projects, agency coordination is required for nearly all recommended corridors with at least one other agency. For example, shared use path corridors along creeks will require permit coordination with Valley Water. For this reason, agency coordination is not considered for trail and shared use path project feasibility.

These criteria are outline in Table 4 below.

Table 4: Trail Network Proposed Evaluation Criteria - Feasibility

CATEGORY	DESCRIPTION
Project Complexity	Project requires significant roadway reconfiguration, ROW acquisition, or significant construction to overcome existing barriers.

Methodology

Projects will be scored based on the tables outlined above. For Priority criteria, projects will be scored on each criterion, and the sum of all criteria will be considered the project's Priority score.

For project feasibility, a project will be considered to have low feasibility on this axis if at least one condition is true. City staff will be invited to review the initial results of priority and feasibility scoring; based on institutional knowledge of the street network, project complexity, and similar, changes may be recommended to better reflect on-the-ground conditions.

Next Steps

City staff are requested to review the criteria and approach outlined above, along with the accompanying maps and project tables. In reviewing prioritization results, please provide feedback specifically related to Feasibility based on City understanding of complexity of coordination. Additional comments on the approach are also welcome.

MEMORANDUM

304 12th Street, Suite 2A
Oakland, CA 94607
(510) 540-5008
www.altaplanning.com

To: Fanny Yu, City of Milpitas

From: Erin David, Alta Planning + Design

Date: May 06, 2020

Re: Milpitas Bicycle and Pedestrian Master Plan Update and Trails Master Plan Update:

Proposed Prioritization Strategy - Spot Improvements DRAFT

Introductions

The following memorandum outlines the proposed prioritization strategy for recommended Spot Improvements as part of the Bicycle + Pedestrian and Trails Mater Plan Updates. This approach is intended to establish a framework that can be used to revisit prioritization as needed to account for future changes in priority as Milpitas continues to grow.

Strategy

Spot improvements represent individual locations on the roadway and trail network that should be improved to better support active travel in the city. Spot improvements can either be implemented individually or can be coordinated with larger corridor improvement projects. While it is recommended that intersection improvements are coordinated with larger projects, near term projects with high feasibility should be considered as immediate improvements. Prioritization for these improvements follows the approach developed through the bicycle and trails prioritization process, with projects grouped into four main categories, as shown in Figure 1.

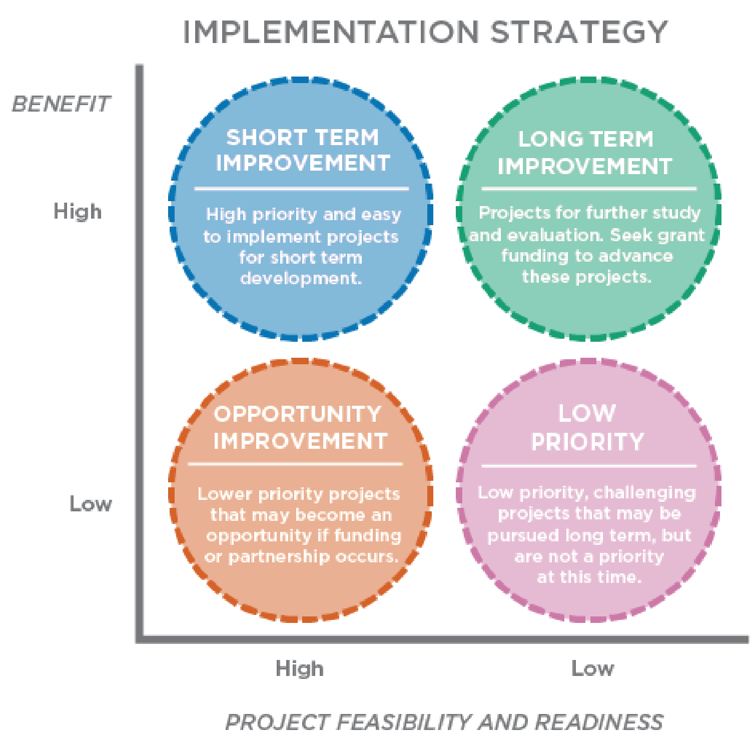

Figure 1: Implementation Strategy Categories

Through this evaluation process, projects will be grouped into four Project Categories that represent varying phases and/or approaches to project implementation. These categories will be based on project priority and relative project feasibility. Each project will be evaluated as "high" or "low" on each axis.

These four categories can be summarized as follows:

- Short term priority projects are rated high priority and high project feasibility
- Long term priority projects are rated high priority and low project feasibility
- Opportunity projects are rated low priority and high project feasibility
- Low priority projects are rated low priority and low project feasibility

Spot Improvement Evaluation Criteria

In order to sort projects into these four overarching categories, a series of criteria will be used to evaluate projects in relation to plan goals and public engagement findings. Table 1 on the next page outlines the details of these criteria. In general, projects benefit or priority will be evaluated based on:

- Connectivity: Does the project provide access to parks, trails, transit, schools, employment centers, or commercial centers?
- Safety: Does the project improve conditions at an intersection that has a history of collisions?
- Pedestrian Improvement: Does the project provide an opportunity to coordinate with a pedestrian improvement?
- Project Support: Is the project supported by the public? (Pending results of Phase 2 input map)

Table 1: Spot Improvement Proposed Evaluation Criteria - Priority

CATEGORY	CRITERIA	DESCRIPTION	SCORING
CONNECTIVITY	Connectivity to Transit, Schools, Parks, and Employment Centers	Project provides connections to transit, including frequent local bus, BART, and light rail; schools (adjacent to school or along identified SRTS route); parks; or employment centers.	Project receives full points if it supports connections to at least 3 of the listed destinations. Project receives partial points for providing connections to fewer than 3 destination categories.
MULTI-MODAL IMPROVEMENT	Multi-Modal Improvement	Project provides an opportunity to introduce traffic calming or other safety improvement measures that benefit other active modes.	Project receives points if it is located within the Pedestrian Priority Improvement Areas or is coincident with trail and bike improvements.
SAFETY	Previous Collision	Project provides safety improvement near reported crash location. Collision occurred at the project intersection.	Project receives full points if a severe injury or fatal collision occurred along the project segment. Project receives partial points if a collision occurred at intersection.
PROJECT SUPPORT	Public Support	Project was supported by the public through this Plan's public engagement activities	Project received at least 1 like or was voted as a priority project.

To evaluate project feasibility, criteria will consider:

- **Project Complexity:** Does the project require significant reconfiguration of the roadway, right-of-way (ROW) acquisition, or similar?

These criteria are outlined in Table 2 below. For feasibility, it is assumed that if a project meets at least one of these criteria, it is considered low feasibility.

Table 2: Spot Improvement Proposed Evaluation Criteria - Feasibility

CATEGORY	DESCRIPTION
Project Complexity	Project requires significant roadway reconfiguration or ROW acquisition.

Methodology

Projects will be scored based on the tables outlined above. For Priority criteria, projects will be scored on each criterion, and the sum of all criteria will be considered the project's Priority score.

For project feasibility, a project will be considered to have low feasibility on this axis if at least one condition is true. City staff will be invited to review the initial results of priority and feasibility scoring; based on institutional knowledge of the street network, project complexity, and similar, changes may be recommended to better reflect on-the-ground conditions.

Next Steps

City staff are requested to review the criteria and approach outlined above, along with the accompanying maps and project tables. In reviewing prioritization results, please provide feedback specifically related to Feasibility based on City understanding of complexity of coordination. Additional comments on the approach are also welcome.

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APPENDIX D

MEMORANDUM

304 12th Street, Suite 2A
Oakland, CA 94607
(510) 540-5008
www.altaplanning.com

To: Fanny Yu, City of Milpitas

From: Alta Planning + Design

Date: June 2, 2020

Re: Milpitas Bicycle and Pedestrian Master Plan: Implementation, Policies, and Pricing Structures

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The following memo outlines the recommendations for the implementation of a Bike and Scooter Share program in Milpitas. The strategy presented here is based on current best practices in other jurisdictions, review of existing conditions and assessment of demand in Milpitas, and the goals and objectives for a shared mobility program as defined by the City. These recommendations are intended to provide a starting point for city implementation; given how rapidly the shared micro-mobility industry is evolving, the City should assess any needed adjustment at the time of implementation, building on the recommendations for partnerships and information sharing outlined in the section that follow.

Further, it should be noted that the COVID-19 public health crisis in 2020 may be dramatically shifting shared mobility options. As scooter service in particular has been suspended in many locations at this time, additional consideration for pilot program parameters and timing of pilot launch is needed. Partnerships with neighboring jurisdictions may be vital to developing a strong and successful system in the future.

RECOMMENDED IMPLEMENTATION STRATEGY

Milpitas should consider **a one-year pilot period** for implementation of a hybrid bike share system and e-scooter program. The one-year evaluation period is consistent with the approach of many other jurisdictions across the United States and provides an opportunity to assess program strengths, challenges, and required adjustments for operations. Specifics such as service area, required policies, vendor requirements, parking and restricted area regulations, and overall fleet size and distribution are items that may be refined after gaining additional understanding of operations in the Milpitas setting. The pilot program approach provides the opportunity to test operations and adjust in subsequent deployments or expansions.

Further, with the upcoming start of BART service in Milpitas and continued investment in making bicycling and pedestrian networks safer and more complete, transportation patterns have the capacity to change drastically in coming years. A pilot period will allow the city to evaluate these changes and what effects it might have on expanding or restricting shared micro-mobility options. Following the one-year pilot, the City can consider program changes, including permitting additional operators, switching to a city-owned and third-party operated system, modifying vehicle limits and service areas, and/or exploring other contract terms for operators.

The City of Fremont implemented a pilot program in 2019 for bike share specifically to better understand many of these questions. It is recommended that Milpitas staff coordinate with Fremont staff to understand lessons learned specific to the region that should be considered in implementation a local program.

SYSTEM TYPE

Based on City-identified goals with consideration for potential service areas, it is recommended that Milpitas implement a **hybrid bike share system** and **e-scooter share system.**

Hybrid Bike Share System with Electric Assist Bikes

The recommended system type for bike share in Milpitas is a hybrid system. A hybrid system will encourage system users to lock at specified hubs but provide options to end the trip at other designated locations; locking requirements can encourage system users to park bikes in areas that do not obstruct other travel.

This type of system will provide the ideal balance of control and flexibility to meet the needs of the Milpitas community, including more ways to connect to transit; the ability to provide service to all residents; promote public health; and lend to long-term sustainability and adaptability of the bike share program.

The fleet should use electric-assist bikes. Electric-assist bikes are consistent with the bikes used in other programs. With an electric bike share system, riders can cover more ground and navigate topography with ease. Electric bikes are more appealing to a larger range of potential users of varying physical abilities. Because electric bikes are powered by a battery, they must be recharged on a regular basis. While this creates an additional operations step for vendors/contractors who must either swap the batteries or dock the bikes at a recharging station, permit requirements can help address these concerns.

E-Scooter Share System

An e-scooter share system should be deployed at the same time as the bike share system. The system should also focus on hubs with rack options and other designated parking locations (see Figure 1). Specific scooter types and accommodations should be determined in coordination with the vendor selection process. However, the approach should include specific consideration for parking and locking mechanisms, as this allows the city to manage scooter parking while maximizing geographic coverage to support a diversity of trip origins and destinations. Additional considerations for both the e-scooter and bike share

Figure 1: A scooter parking zone encourages system users to lock scooters in designated areas.

system requirements are explored in the sections that follow.

SERVICE AREA

Based on City goals for the program, an understanding of existing infrastructure, and intent to gather data on demand for shared mobility, it is recommended that the pilot program launch in a more focused area of Milpitas. The initial service areas for bike share and e-scooter share are proposed in differing locations, as shown in in Figure 2 below.

Figure 2 below depicts the recommended service areas for pilot launch. The recommended bike share service area considers the city goals to promote connections to transit while also responding to existing barriers in the network. For example, current conditions do not provide for a low-stress route across I-880, creating a clearly defined edge for the service area to the west. Along with the service areas, locations for shared mobility hubs are indicated. These hubs are locations where parking options dedicated to bike share are located. Selection and implementation of parking hubs may require coordination with private property owners. Finally, an expansion area for bike share is defined; this area represents potential new areas to expand bike share service and news hubs over time. The expansion area extends the service area to the majority of the city. These areas show high potential demand bicycle use and will promote access from these peripheral areas to the center of the city. The expansion area should be approached incrementally, particularly in areas where improved bicycle infrastructure is

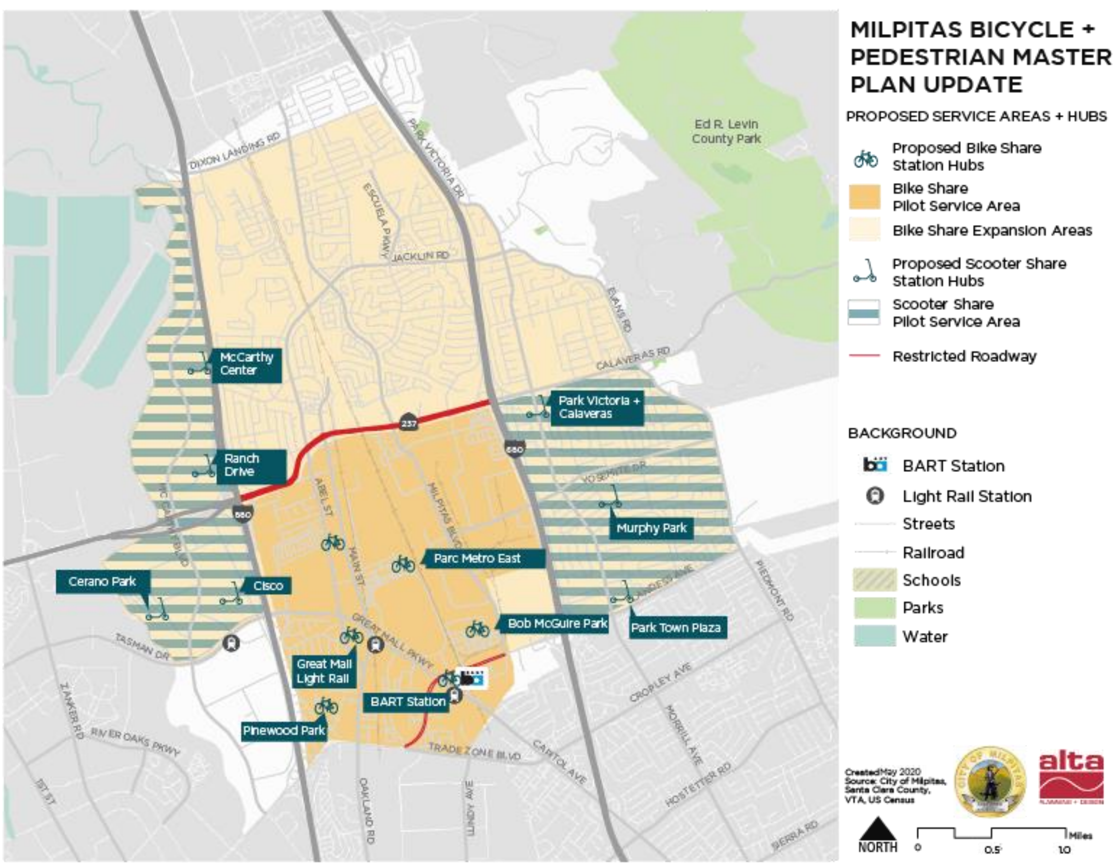


Figure 2: Recommended service area for pilot launch and expansion

needed to support crossing of barriers (e.g., I-880). It is not necessary to expand all at once. The timing and size of the expansion should consider ridership, funding opportunities, and the arrival of new bicycle infrastructure. It is important to note that travel by shared mobility device is not recommended along Calaveras Boulevard of Montague Expressway. In both the pilot launch and expansion of the systems, these roadways should be considered restricted, and the City should coordinate with the vendor on options to encourage and enforce this restriction.

Two potential pilot service areas for scooters are recommended west of I-880 along MCarthy Blvd., and in the southeastern area of the city. In both locations, potential demand for shared mobility is moderate-to-high and can help the city evaluate demand for scooters, identify considerations for expanded service, and evaluate parking requirements. Starting in the initial service area provides the opportunities for residents and visitors to become comfortable with shared micro-mobility on city streets and build support for bike and scooter share and infrastructure before it expands to other neighborhoods. Expansion areas are not defined for scooter share as more data and understanding of the role of scooters in the city is needed.

FLEET SIZE

The initial bike share launch proposes up to **250 electric-assist bikes** distributed among **6 hubs**, depending on the demand and available space within the right of way. The initial scooter share launch proposes up to **250 e-scooters** distributed among **7 hubs**; the City should coordinate with employers located in the service areas—particularly along McCarthy Boulevard—to explore options for additional hubs in support of these campuses. It is recommended that the city begins with a conservative number of vehicles and consider providing the opportunity to expand fleet size when certain performance metrics are met, such as number of trips.

LAUNCH CONSIDERATIONS

Timing of the pilot program launch should provide ample opportunity for coordination with other agencies, private property owners, and others who can support launch of the program. Coordination with city festivals or other large events can provide venues for connecting directly with residents and visitors to answer questions, promote the program, and generate excitement for the addition of shared mobility options. Program launch should also include a robust marketing and outreach strategy that engages transit riders, local employers, and other groups. While bikes and scooters should be available all year, it is recommended that the program is launched in a season with generally more favorable weather conditions.

Further, the launch of the scooter and bike share program should occur at approximately the same time to optimize communications and promotional efforts. If this is not possible, it is acceptable to launch at different times.

CONSIDERATIONS FOR OPERATOR SELECTION

It is recommended that Milpitas select a private operator for pilot bike and scooter share system deployment. Private operators can bring extensive knowledge and experience from operating in other cities and limit the need for Milpitas to hire new staff.

Hiring a private operator still allows Milpitas to dictate the terms for bike and e-scooter share service level agreements. Milpitas should require prospective operators to submit their plans for routine maintenance and operation during the bid process, as well as provide evidence of high performance in other jurisdictions. The pilot program should consider working with only one operator to provide for greater flexibility in adjusting the program in response to the current conditions.

Application and Permitting Process

Operators should successfully complete the application process and be issued a permit to operate within Milpitas. The purpose of this permit is to promote the safe use of the city's public right-of-way and provide for the safe and responsible operations of shared micro-mobility operations. The permit application requirements should include the following elements:

- Program scope
- Safe operations
- Parking and re-balancing of devices
- Equipment and maintenance
- Customer service, including a set response time to incidences
- Device technology, including geofencing capabilities for restricted areas
- Education and outreach requirements
- Data sharing and privacy
- Deposit and fees
- Insurance and indemnification

Based on fees implemented in nearby jurisdictions, application fees of approximately $2,500 should be paid by the vendor with an annual permit and program monitoring fee of $94 per vehicle.[1] In addition, operators should provide a performance deposit of $20,000 to cover public property repair and maintenance related to the impacts of the operator's devices.

Program Scope

It's recommended that the city is given the ability to make modifications to the regulations to better meet the needs of residents, including placing limits on the program size. This can be done by limiting the number of operators or devices by allowing a fixed number of devices per operator or invoking "dynamic capping," a market-based approach that limits devices based on usage rather than total. Dynamic capping sets a performance standard or range of the number of trips taken by device per day to limit the number of devices deployed while simultaneously meeting user demand. Compliance with

[1] This is the cost for a permit in San Jose, California. Application costs should be discussed within the City to determine appropriate fees.

any limitation on size, aera, or scope can be monitored through the data sharing requirements (see Data Sharing section below).

Operations, Maintenance, and Customer Service

Considerations for selecting an operator should include:

- **Re-Balancing:** A hybrid system encourages parking at specific locations but permits system users to lock to other specific locations. The selected operator should be able to demonstrate how they will maintain bike and scooter availability in the service area, including regular charging of bikes and scooters. Permit requirements should consider specifying distribution targets.
- **Parking:** Shared micro-mobility devices must be parked upright in a way that does not impede ADA clearance or obstruct pedestrian traffic flow. Devices are required to be locked to an approved rack or other object, preferably in the park strip adjacent to the sidewalk or in the furniture zone, when present. The devices should not block fire hydrants or other emergency facilities; above- and under-ground utilities; sidewalks, curb ramps, ADA ramps, public or private driveways, pathways, or entryways; handicapped parking zones, loading zones, and bus boarding zones; transit access, ingress, or egress and light rail platforms; and bicycle racks, public restrooms, and newspaper racks. Operators should also not place devices in landscaped park strips in front of single-family homes. The city may designate parking zones in certain areas of the city to better manage the location of parked devices.
- **Equipment**: Devices will be required to meet State codes, policies, and standards as well as local ordinances and rules. This includes speed limit and sidewalk riding restrictions.
- **Vehicle Maintenance:** The selected operator will be responsible for ongoing maintenance of bikes and scooters as well as hub locations. Agreements should include specific maintenance protocols and consider penalties for noncompliance with the agreement.
- **Customer Service:** Operators are responsible for bike and e-scooter share customer service and should have a call center, online portal, and service center to help resolve technical and mechanical issues. Milpitas should request operators to be accessible 24 hours a day, and provide multilingual services including English, Spanish, and Vietnamese. Operators should be required to respond to and address any incidences within two hours of receiving the complaint.
- **Technology:** To comply with restricted zones, further exploration into ways that technology can support service areas should be explored. Existing mechanisms, including geofencing to limit the areas the bike or e-scooter can access, or incentives/disincentives can be used to enforce restricted zones. Restricted zones should be enforced in areas of high pedestrian activity, transit use, and other areas as determined by the city. The City should evaluate each permitee’s compliance with this requirement and track the industry’s overall progress with restricted area technology.
- **User Education + Outreach:** The operator should provide for user education regarding parking requirements, where to operate the vehicle, and other rules of the road. Operators should also

be required to educate their users and to post state and local laws regarding legal and safe use of their devices on their website, mobile app, and the devices themselves in a manner that is accessible and legible to all users. Additionally, it is recommended that the city require the operator to staff representatives in the area to answer questions and distribute information during the first weeks of deployment. Milpitas can also require that the operator provide marketing and outreach materials and staff for major community events at no cost to the City as well as meet with target businesses, community leaders, and community organizations to promote the bike and e-scooter share system within the community.

LIABILITY

The City, in close consultation with their legal team, should identify liability considerations for operator contracts. These liability considerations should place all liability on the operator and require the operator to indemnify, hold harmless, and defend the City (including its elected officials, officers, agents, and employees) from and against any claims, litigations, demands, damages, liabilities, costs, and expenses, including court costs, attorney's fees, expert fees, and other costs and fees of litigation or other dispute resolution proceedings resulting or arising from the operator's performance or failure to perform. It is also recommended that the City require the operator to obtain insurance as part of their permit application. For further information regarding liability considerations, it is recommended that Milpitas staff coordinate with Fremont or San Jose staff to share information regarding local best practices.

ENFORCMENT

The City should establish a clear system with the vendor to address issues related to vehicle maintenance, parking, or other requirements of the permit program. Other systems have included options to reduce the number of vehicles allowed, impose fines, or require additional actions in the case of permit requirements not being met. For example, if parking requirements are not being observed and the vendor does not respond in a timely manner, the number of permitted vehicles allowed may be reduced for a set amount of time or until certain performance metrics are achieved.

User behavior, including following the rules of the road, will be enforced by the local police department. The City should coordinate closely with the police department to both identify concerns prior to launching the program as well as establish a process for communicating any issues or concerns they have as the program is implemented.

DATA SHARING REQUIREMENTS

GPS-enabled micro-mobility devices generate a wealth of transportation data that is useful for monitoring compliance, providing users and mobility app developers with real-time information on the availability and location of shared devices, and contributing to City planning efforts. Data requirements include data in the Mobility Data Specification (MDS) which includes anonymized information on trips, rides, number of devices, and other system usage statistics to be used in planning efforts; General Bike

Feed Specification (GBFS) which allows system availability and status information to be shared with the public and third-party operators; and anonymized reporting on system use, memberships, low-income programs, and other pertinent data. It is also recommended that the operator provide the city with timestamped records of maintenance activities, customer service inquiries, and safety issues.

SYSTEM FARES + PRICING STRUCTURE

It is recommended that Milpitas require a pricing structure that is comparable to Bay Wheels and other existing bike and e-scooter share systems in neighboring municipalities. It is recommended that Milpitas invest in a variety of payment options, including monthly memberships, annual memberships, equitable memberships, single ride fares, and station access passes. The fares listed below are intended to be guidelines based on systems in nearby jurisdictions.

Single rides for both e-scooters and bikes should can include an unlock fee (typically $1) and a per-minute fee of $0.20 for bikes. E-scooter per minute fees may vary, with area costs typically around $0.25.

Access passes at $10 a day should allow membership for one day, with unlimited unlocks in a 24-hour period.

Monthly and Annual memberships should provide for unlimited unlocks and reduced per-minute fees. Cost should reflect regional rates, which are approximately $15/month or $149 for an annual membership.

Bike Share for All, as highlighted in the next section, should offer affordable transportation costs for qualifying residents. This program should accept prepaid cards to make payments for convenient for users.

Parking Fees: Additional fees should be considered for users who park vehicles outside of the designated service area or lock to locations not designated by the program. Similarly, bonuses can be offered to users who return vehicles to the service area and specific hub locations.

EQUITY

In order to provide a service that meets the needs of all users, the bike and e-scooter share should consider including the following elements in their bike and e-scooter share system:

Income-Based Discounts: The vast majority of bike and e-scooter share systems that pursue equity goals, regardless of size, have plans that address the financial barriers to users. Income based-discounts and cash payment options are key strategies to include lower income bike share riders who may not have access to credit or may not be able to afford the transportation service at the standard fare.

Cash Payment: Over the past couple years, many bike and e-scooter share providers, both public and private, have implemented cash payment options where users can go to designated locations to add cash to their accounts. Reload locations are often social service provides, bike share offices, and local grocery/convenience stores.

Alternative Payment Structures: Beyond income-based discounts and cash payment options, bike and e-scooter share systems should consider other alternative payment structures in order to reduce the financial barriers to entry. For example, rather than offering either a year-long pass or weekly passes, bike and e-scooter share providers could consider offering monthly passes which cater to regular users who can’t afford the high total cost of a year-long pass or the high per-trip cost of a weekly pass. Additionally, providing longer rental times can alleviate fears of overage charges.

Reduce Liability and Eliminate Hidden Fees: Some bike and e-scooter share systems require a deposit or have steep fees for lost or stolen bikes or scooters. Eliminating these fees across the board or just for lower income users can make people feel more comfortable using the system.

Targeted Marketing: Targeted marketing is any content that increases awareness of the bike and e-scooter share among demographics and populations that may benefit from additional outreach. This is a key way providers pursue equity goals. Targeted marketing should reflect the diversity of the area and the system it serves. It should reinforce the idea that the system is for people who live in Milpitas, and not just visitors looking for recreational amenities. Successful content is created for (and often with the help of) specific groups and communities the bike and e-scooter share hope to engage. These strategies could include: ambassador photos shoots, press releases, social media, billboards, bus-stop displays, bike station panels, flyers, emails, custom painted or sponsored bikes/scooters by community partners. Regardless or marketing strategy, it is recommended that the content is produced in the languages and located in the places that the target population occupies.

Bikeshare for All: Based on the recommendation outlined above, Milpitas should create a comparable program to Bay Wheel's Bike Share for All, promoting affordable, accessible, and fun transportation for everyone, no matter their socio-economic status. Milpitas residents who qualify for CalFresh, SFMTA Lifeline Pass, or PG&E CARE utility discount should be eligible to join the Bikeshare for All program for just $5 for the first year. This program should also make sure to accept prepaid cards.

OTHER CONSIDERATIONS FOR CITY POLICY:

- **No Sidewalk Riding:** The City should restrict bicyclists and e-scooters from riding in areas of high pedestrian activity, transit use, and other such areas as determined by the City. This can be enforced via technology, incentives, or fines.
- **Restricted Areas:** Users are not permitted to operate scooter or bike share vehicles along specific corridors, including Montague Expressway. The City should coordinate with the selected operator on methods for implementation, including geo-fencing and rider notifications. Similar to system requirements in place in Fremont, the city should consider designating certain block faces or areas as no parking, no deployment, or no- riding zones.
- **Trails:** For city owned- and operated trails, City policy should be clarified to specify if scooters or bike share vehicles can be operated here. It is recommended that they are permitted on trails within the city limits to support access to low-stress facilities.
- **Consistency with Neighboring Jurisdictions:** San Jose and Fremont both have existing systems that Milpitas should considering modeling after for consistency of user experience. With a focus on BART and transit connections, it is recommended that the system is first consistent with San Jose. Given the close proximity to the city boundary for these primary transit connections, a more seamless experience for users is recommended.
- **Age Restrictions:** Bike and e-scooter use should be limited to those who are ages 18 or older.

PERFORMANCE METRICS

Establishing a set of performance metrics for the system can help the City evaluate program success and expansion and also provide common understanding with operators for system operations. Performance metrics should reflect City goals for the system and potential challenges based on lessons learned from other jurisdictions. Benchmarks related to established performance metrics can also provide opportunities for fleet expansion or reduction.

Performance metrics the city should consider include:

- **Ridership:** Consider total users, trips per vehicle, total trips, and number of unique users. Location-based measures can inform hubs that are not performing as well and locations where hubs may be better suited.
- **Equity:** Consider number of users enrolled in public assistance and number of users utilizing alternative payment options. Additional considerations may include number of trips starting or ending near service providers, affordable housing locations, or similar.
- **Distribution Compliance:** Is the operator compliant with distribution requirements set out as part of the permitting process?
- **Complaint Response:** How responsive is the operator to identified issues, including parking concerns, vehicle maintenance and operability, and hub functionality?
- **Safety:** Consider the number of collisions per miles traveled
- **Trip Characteristics:** Consider average trip length (time), average trip distance, and total miles for the system.

COLLABORATION

This study recommends that Milpitas pursue collaborative partnerships with other agencies, community-based organizations, and other relevant groups. Partnerships will help build support for the bike share system, increase ridership, site stations, and raise funding. The following lists shows potential partners:

- Major employment centers, such as Cisco and Western Digital
- Milpitas Unified School District
- Valley Transportation Authority
- Santa Clara County
- Santa Clara Public Health
- Metropolitan Transportation Commission
- Bay Area Bike Share and Partner Cities

Next Steps

The City should review the recommendations provided to determine additional considerations for a bike and scooter share program. Close coordination with area jurisdictions and agencies is encouraged, particularly for shared of permit and application materials, lessons learned, and coordination for system selection. Further resident engagement may also be useful, including a survey of residents and employees to gain insight into potential demand, service areas, and price considerations.

APPENDIX E

THE CITY OF MILPITAS

Design Guidelines

Trail, Pedestrian, and Bicycle Master Plan

June 2021

Contents

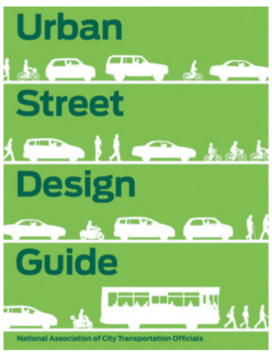
INTRODUCTION

This Design Guide presents a toolbox of current design guidance and standards to implement bicycle and pedestrian improvements. It has been developed to complement the City's Trail, Pedestrian, and Bicycle Master Plan and reflects other nationally recognized efforts to promote pedestrian and bicycle safety and comfort. The information assembled here is not, however, a substitute for a more thorough evaluation by a professional engineer prior to implementation of facility improvements with considerations to physical, right of way, and other constraints.

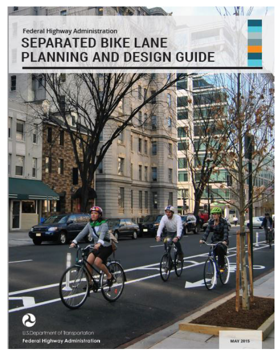
Guidance Basis

The sections that follow serve as an inventory of pedestrian and bicycle design treatments and provide guidelines for their development. These treatments and design guidelines are important because they represent the tools for creating a pedestrian- and bicycle-friendly, accessible community. The design guidance offered here are reflected in the following national and state sources.

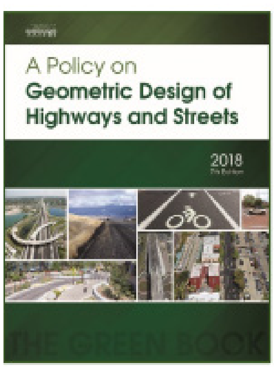
NATIONAL GUIDANCE



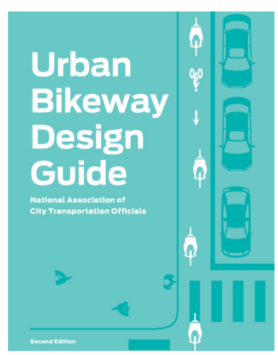
The National Association of City Transportation Officials' (NACTO) Urban Bikeway Design Guide (2012) and Urban Street Design Guide (2013) are collections of nationally recognized street design standards, and offers guidance on the current state of the practice designs.



Separated Bike Lane Planning and Design Guide (2015) is the latest national guidance on the planning and design of separated bike lane facilities released by the Federal Highway Administration (FHWA). The resource documents best practices as demonstrated around the U.S., and offers ideas on future areas of research, evaluation and design flexibility.



A Policy on Geometric Design of Highways and Streets (2018) provides national guidance onthe design of highways and streets. The 7th edition of the "The Green Book" offers an updated framework for geometric design that is more flexible, multimodal, and performance based than in previous editions.

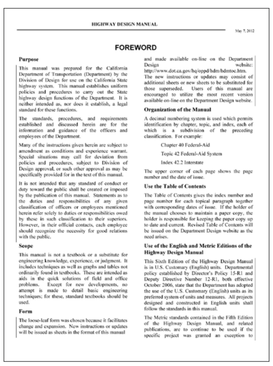


The National Association of City Transportation Officials' (NACTO) Urban Bikeway Design Guide (2012) provides cities with state-of-the-practice solutions that can help create complete streets that are safe and enjoyable for bicyclists. The designs were developed by cities for cities, since unique urban streets require innovative solutions. In August 2013, the Federal Highway Administration issued a memorandum officially supporting use of the document.

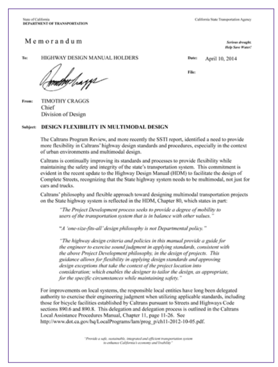
CALIFORNIA GUIDANCE

The California Manual on Uniform Traffic Control Devices (CAMUTCD) (2014) is an amended version of the FHWA MUTCD 2009 edition modified for use in California. While standards presented in the CA MUTCD substantially conform to the FHWA MUTCD, the state of California follows local practices, laws and requirements with regards to signing, striping and other traffic control devices.

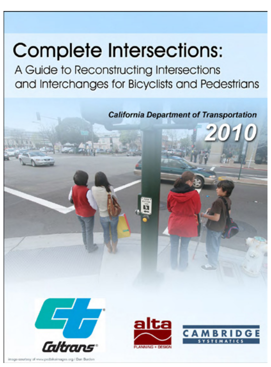
Main Street, California: A Guide for Improving Community and Transportation Vitality (2013) reflects California's current manuals and policies that improve multimodal access, livability and sustainability within the transportation system. The guide recognizes the overlapping and sometimes competing needs of main streets.



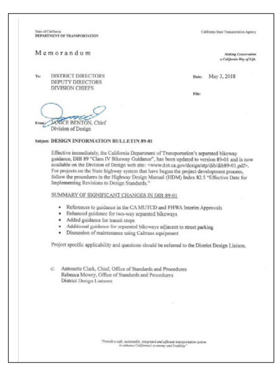
The California Highway Design Manual (HDM) (Updated 2015) establishes uniform policies and procedures to carry out highway design functions for the California Department of Transportation.



The Caltrans Memo: Design Flexibility in Multimodal Design (2014) encourages flexibility in highway design. The memo stated that "Publications such as the National Association of City Transportation Officials (NACTO) "Urban Street Design Guide" and "Urban Bikeway Design Guide," … are resources that Caltrans and local entities can reference when ma king planning and design decisions on the State highway system and local streets and roads."



Complete Intersections: A Guide to Reconstructing Intersections and Interchanges for Bicyclists and Pedestrians (2010) is a reference guide presents information and concepts related to improving conditions for bicyclists and pedestrians at major intersections and interchanges. The guide can be used to inform minor signage and striping changes to intersections, as well as major changes and designs for new intersections.



Caltrans Design Information Bulletin 89-01 provides enhanced guidance for two-way separated bikeways, with added information on transit stops and separated bikeways adjacent to street parking. It also provides a discussion of maintenance using Caltrans equipment.

Facility Selection: Bicycle User Type

The current AASHTO Guide to the Development of Bicycle Facilities encourages designers to identify their rider type based on the trip purpose (Recreational vs Transportation) and on the level of comfort and skill of the rider (Causal vs Experienced). A user-type framework for understanding a potential rider's willingness to bike is illustrated in the figure below. Developed by planners in Portland, OR* and supported by research**, this classification identifies four distinct types of bicyclists.

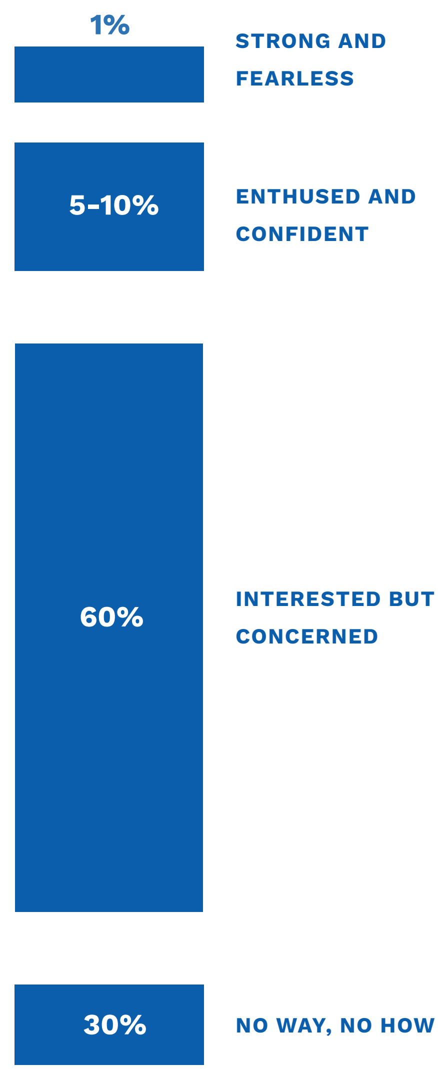
Strong and Fearless – This group is willing to ride a bicycle on any roadway regardless of traffic conditions. Comfortable taking the lane and riding in a vehicular manner on major streets without designated bicycle facilities.

Enthused and Confident - This group of people riding bicycles who are riding in most roadway situations but prefer to have a designated facility. Comfortable riding on major streets with a bike lane.

Interested but Concerned – This group is more cautious and has some inclination towards bicycling, but are held back by concern over sharing the road with cars. Not very comfortable on major streets, even with a striped bike lane, and prefer separated pathways or low traffic neighborhood streets.

No Way, No How – This group comprises residents who simply aren't interested at all in bicycling and may be physically unable or don't know how to ride a bicycle, and they are unlikely to adopt bicycling in any way.

TYPICAL DISTRIBUTION OF BICYCLIST TYPES



** Roger Geller, City of Portland Bureau of Transportation. Four Types of Cyclists. http://www.portlandonline.com/transportation/index.cfm?&a=237507. 2009.*
*** Dill, J., McNeil, N. Four Types of Cyclists? Testing a Typology to Better Understand Bicycling Behavior and Potential. 2012.*

Facility Selection: Comfort

In order to provide a bikeway network that meets the needs of the Milpita's "Interested but Concerned" residents (who comprise the majority of the population), bikeways must be low-stress and comfortable. By using a metric called Level of Traffic Stress (LTS), specific facility types can be matched to the needs of people who bicycle in Milpitas. Generally, "Interested but Concerned," users will only bicycle on LTS 1 or LTS 2 facilities.

LEVELS OF TRAFFIC STRESS (LTS)

LTS LEVEL	DESCRIPTION	WHAT TYPE OF BICYCLISTS WILL RIDE ON THIS LTS FACILITY?		
		STRONG & FEARLESS	ENTHUSIASTIC & CONFIDENT	INTERESTED BUT CONCERNED
LTS 1	Presents the lowest level of traffic stress; demands less attention from people riding bicycles, and attractive enough for a relaxing bicycle ride. Suitable for almost all people riding bicycles, including children trained to ride in the street and to safety cross intersections.	YES	YES	YES
LTS2	Presents little traffic stress and therefore suitable to most adults riding bicycles, but demandsmore attention than might be expected from children.	YES	YES	SOMETIMES
LTS3	More traffic stress than LTS2, yet significantly less than the stress of integrating with multilane traffic.	YES	SOMETIMES	NO
LTS4	A level of stress beyond LTS 3. Includes roadways that have no dedicated bicycle facilities and moderate to higher vehicle speeds and volumes OR high speed and high volume roadways WITH an exclusive riding zone (lane) where there is a significant speed differential with vehicles.	YES	NO	NO

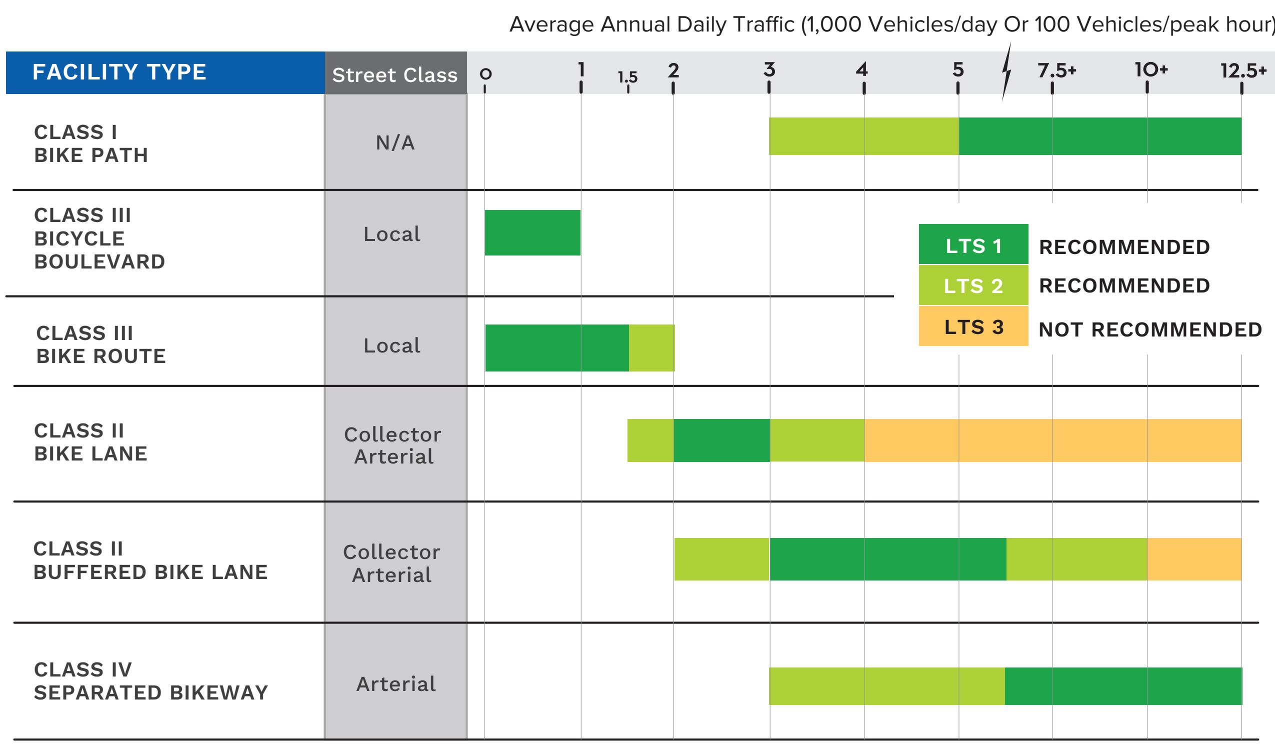
Facility Selection: Bikeways

Selecting the best bikeway facility type for a given roadway can be challenging, due to the range of factors that influence bicycle users' comfort and safety. There is a significant impact on cycling comfort when the speed differential between bicyclists and motor vehicle traffic is high and motor vehicle traffic volumes are high. This page can help determine when a Class IV Bikeway is most appropriate relative to other facility types.

Facility Selection Table

As a starting point to identify a preferred facility, the chart below can be used to determine the recommended type of bikeway to be provided in particular roadway speed and volume situations. To use this chart, identify the appropriate daily traffic volume on the existing or proposed roadway, and locate the facility types indicated by those key variables.

Other factors beyond volume which affect facility selection include traffic speed, traffic mix of automobiles and heavy vehicles, the presence of on-street parking, intersection density, surrounding land use, and roadway sight distance. These factors are not included in the facility selection chart below, but should always be considered in the facility selection and design process.



(Average Daily Vehicles, per 1,000)

Design Needs of Pedestrians

The CA MUTCD recommends a normal walking speed of 3.5 ft per second when calculating the pedestrian clearance interval at traffic signals. The walking speed can drop to 3 ft per second for areas with older populations and persons with mobility impairments. While the type and degree of mobility impairment varies greatly across the population, the transportation system should accommodate these users to the greatest reasonable extent.

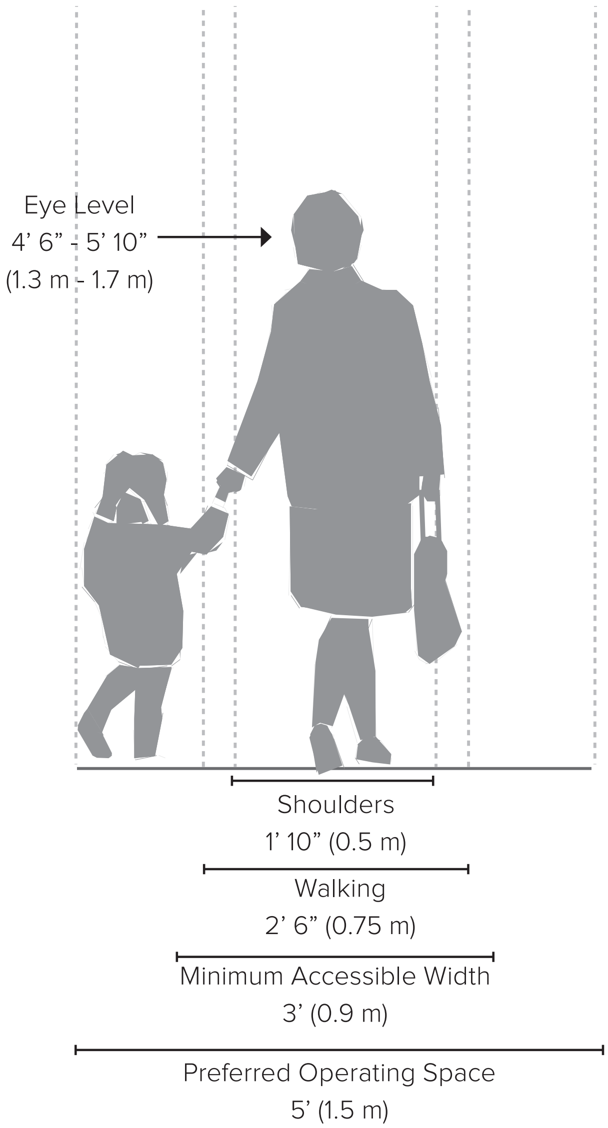
Types of Pedestrians

Pedestrians have a variety of characteristics and the transportation network should accommodate a variety of needs, abilities, and possible impairments. Age is one major factor that affects pedestrians' physical characteristics, walking speed, and environmental perception. Children have low eye height and walk at slower speeds than adults. They also perceive the environment differently at various stages of their cognitive development. Older adults walk more slowly and may require assistive devices for walking stability, sight, and hearing.

Disabled Pedestrian Design Considerations

The table below summarizes common physical and cognitive impairments, how they affect personal mobility, and recommendations for improved pedestrian-friendly design.

IMPAIRMENT		DESIGN SOLUTION
Physical Impairment Necessitating Wheelchair and Scooter Use	Difficulty propelling over uneven or soft surfaces.	Firm, stable surfaces and structures, including ramps or beveled edges.
	Cross-slopes cause wheelchairs to veer downhill or tip sideways.	Cross-slopes of less than two percent.
	Require wider path of travel.	Sufficient width and maneuvering space.
Physical Impairment Necessitating Walking Aid Use	Difficulty negotiating steep grades and cross slopes; decreased stability and tripping hazard.	Cross-slopes of less than two percent. Smooth, non-slippery travel surface.
	Slower walking speed and reduced endurance; reduced ability to react.	Longer pedestrian signal cycles, shorter crossing distances, median refuges, and street furniture.
Hearing Impairment	Less able to detect oncoming hazards at locations with limited sight lines (e.g. driveways, angled intersections, channelized right turn lanes) and complex intersections.	Longer pedestrian signal cycles, clear sight distances, highly visible pedestrian signals and markings.
Vision Impairment	Limited perception of path ahead and obstacles; reliance on memory; reliance on non-visual indicators (e.g. sound and texture).	Accessible text (larger print and raised text), accessible pedestrian signals (APS), guide strips and detectable warning surfaces, safety barriers, and lighting.
Cognitive Impairment	Varies greatly. Can affect ability to perceive, recognize, understand, interpret, and respond to information.	Signs with pictures, universal symbols, and colors, rather than text.



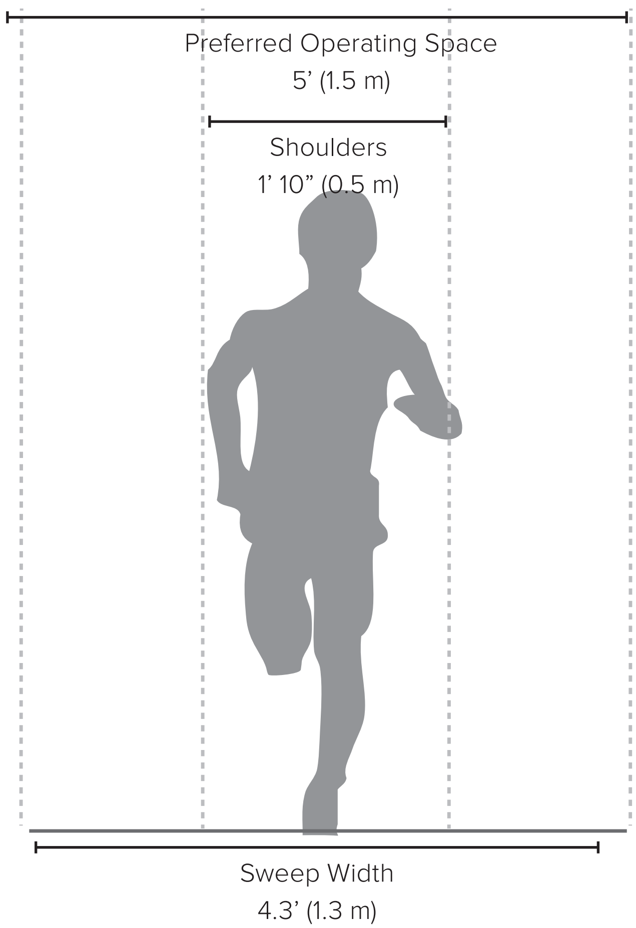
PEDESTRIAN CHARACTERISTICS BY AGE

AGE	CHARACTERISTICS
0-4	Learning to walk Requires constant adult supervision Developing peripheral vision and depth perception
5-8	Increasing independence, but still requires supervision Poor depth perception
9-13	Susceptible to “darting out” in roadways Insufficient judgment Sense of invulnerability
14-18	Improved awareness of traffic environment Insufficient judgment
19-40	Active, aware of traffic environment
41-65	Slowing of reflexes
65+	Difficulty crossing street Vision loss Difficulty hearing vehicles approaching from behind

Source: AASHTO. Guide for the Planning, Design, and Operation of Pedestrian Facilities, Exhibit 2-1. 2004.

Design Needs of Runners

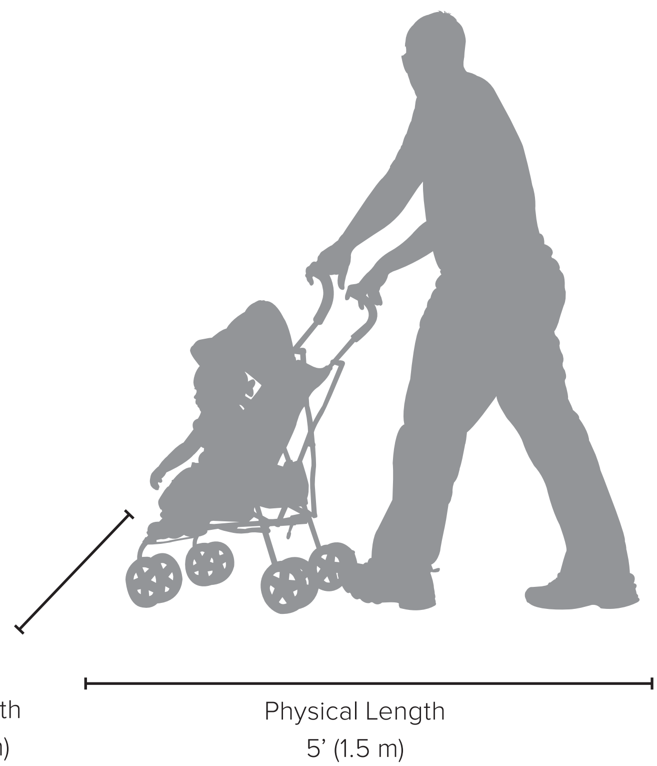
Running is an important recreation and fitness activity commonly performed on shared use paths. Many runners prefer softer surfaces (such as rubber, bare earth or crushed rock) to reduce impact. Runners can change their speed and direction frequently. If high volumes are expected, controlled interaction or separation of different types of users should be considered.



Design Needs of Strollers

Strollers are wheeled devices pushed by pedestrians to transport babies or small children. Stroller models vary greatly in their design and capacity. Some strollers are designed to accommodate a single child, others can carry 3 or more. Design needs of strollers depend on the wheel size, geometry and ability of the adult who is pushing the stroller.

Strollers commonly have small pivoting front wheels for easy maneuverability, but these wheels may limit their use on unpaved surfaces or rough pavement. Curb ramps are valuable to these users. Lateral overturning is one main safety concern for stroller users.



Design Needs of Wheelchair Users

As the American population ages, the age demographics in Milpitas may also shift, and the number of people using mobility assistive devices (such as manual wheelchairs, powered wheelchairs) will increase.

Manual wheelchairs are self-propelled devices. Users propel themselves using push rims attached to the rear wheels. Braking is done through resisting wheel movement with the hands or arm. Alternatively, a second individual can control the wheelchair using handles attached to the back of the chair.

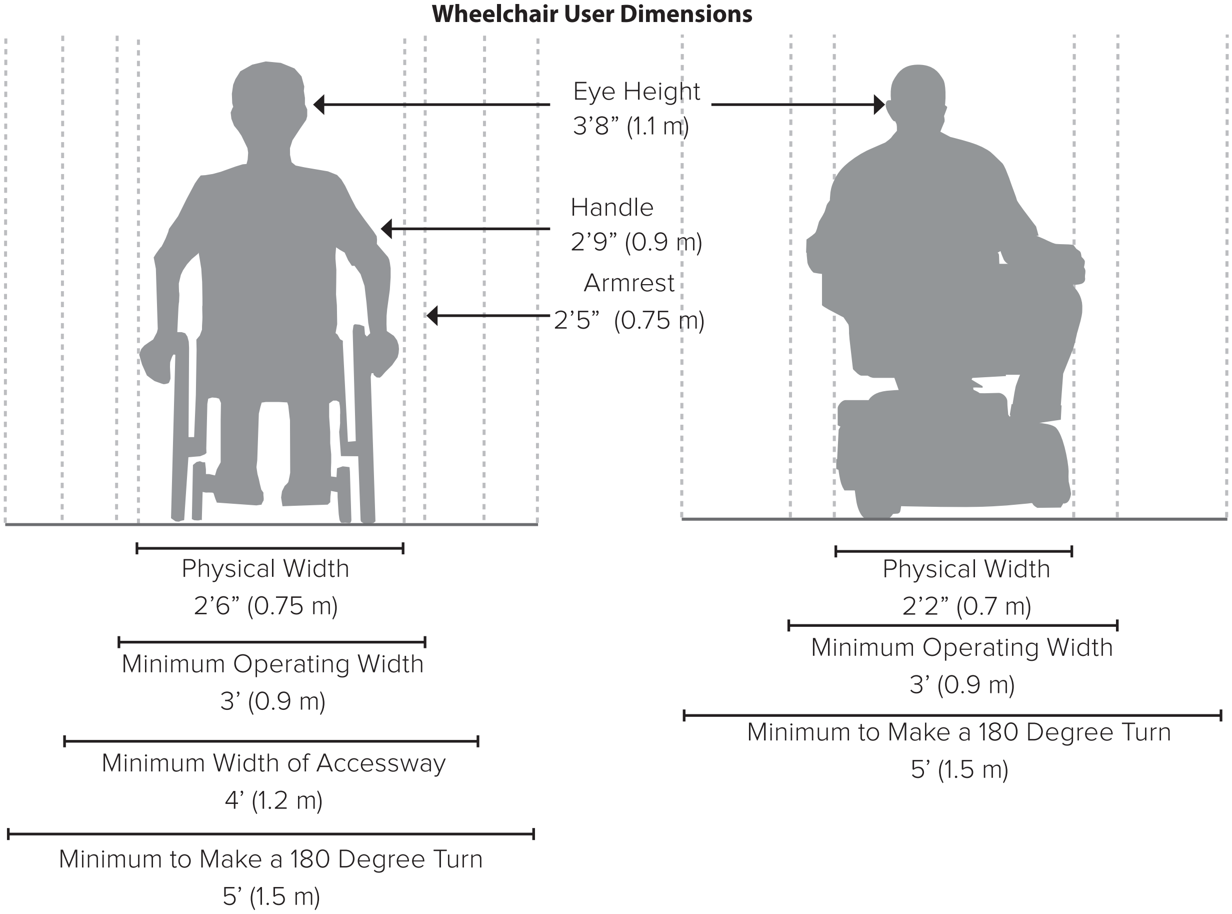
Power wheelchairs use battery power to move the wheelchair. The size and weight of power wheelchairs limit their ability to negotiate obstacles without a ramp. Various control units are available that enable users to control the wheelchair movement, based on their ability (e.g., joystick control, breath controlled, etc).

Maneuvering around a turn requires additional space for wheelchair devices. Providing adequate space for 180 degree turns at appropriate locations is an important element of accessible design.

WHEELCHAIR USER DESIGN CONSIDERATIONS

Effect on Mobility	Design Solution
Difficulty propelling over uneven or soft surfaces.	Firm, stable surfaces and structures, including ramps or beveled edges.
Cross-slopes cause wheelchairs to veer downhill.	Cross-slopes of less than two percent.
Require wider path of travel.	Sufficient width and maneuvering space.

Wheelchair User Dimensions



Design Needs of Bicyclists

The facility designer must have an understanding of how bicyclists operate and how their bicycle influences that operation. Bicyclists, by nature, are much more affected by poor facility design, construction and maintenance practices than motor vehicle drivers. By understanding the unique characteristics and needs of bicyclists, a facility designer can provide quality facilities and minimize user risk.

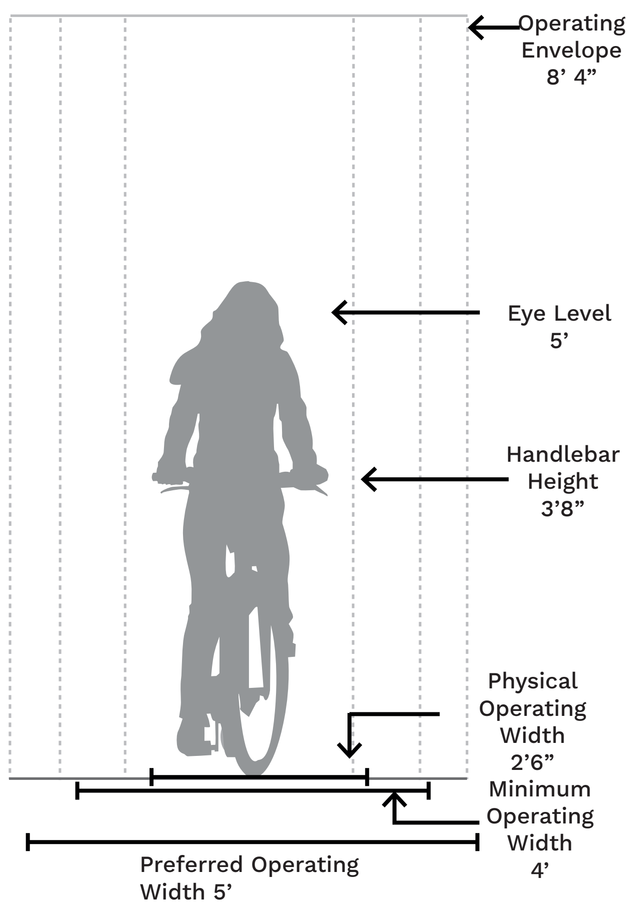
Bicycle as a Design Vehicle

Similar to motor vehicles, bicyclists and their bicycles exist in a variety of sizes and configurations. These variations occur in the types of vehicle (such as a conventional bicycle, a recumbent bicycle or a tricycle), and behavioral characteristics (such as the comfort level of the bicyclist). The design of a bikeway should consider reasonably expected bicycle types on the facility and utilize the appropriate dimensions.

The Bicycle Rider figure illustrates the operating space and physical dimensions of a typical adult bicyclist, which are the basis for typical facility design. Bicyclists require clear space to operate within a facility. This is why the minimum operating width is greater than the physical dimensions of the bicyclist. Bicyclists prefer five feet or more operating width, although four feet may be minimally acceptable.

In addition to the design dimensions of a typical bicycle, there are many other commonly used pedal-driven cycles and accessories to consider when planning and designing bicycle facilities. The most common types include tandem bicycles, recumbent bicycles, and trailer accessories.

BICYCLE RIDER - TYPICAL DIMENSIONS



BICYCLE AS DESIGN VEHICLE - DESIGN SPEED EXPECTATIONS

BICYCLE TYPE	FEATURE	TYPICAL SPEED
Upright Adult Bicyclist	Paved level surfacing	8-12 mph*
	Crossing Intersections	10 mph
	Downhill	+ 20 mph
	Uphill	5 -12 mph
Recumbent Bicyclist	Paved level surfacing	18 mph

** Typical speed for causal riders per AASHTO 2013.*

PEDESTRIAN FACILITIES


4 HR LIMIT
PAY TO PARK

Sidewalk Zones & Widths

Sidewalks are the most fundamental element of the walking network, as they provide an area for pedestrian travel separated from vehicle traffic. Providing adequate and accessible facilities can lead to increased numbers of people walking, improved accessibility, and the creation of social space.

ENHANCEMENT ZONE	BUFFER ZONE	PEDESTRIAN THROUGH ZONE	FRONTAGE ZONE
The **enhancement zone** can act as a flexible space to further buffer the sidewalk from moving traffic, and may be used for a bike lane. Curb extensions, cafe seating, and/or bike parking may occupy this space where appropriate. In the **enhancement zone** there should be a 6 inch wide curb.	The **buffer zone,** also called the furnishing or landscaping zone, buffers pedestrians from the adjacent roadway, and is also the area where elements such as street trees, signal poles, signs, and other street furniture are properly located.	The **pedestrian through zone** is the clear area intended for pedestrian travel. This zone should be entirely free of permanent and temporary objects. Wide through zones are needed in downtown areas or where pedestrian flows are high.	The frontage zone allows pedestrians a comfortable "shy" distance from the building fronts. It provides opportunities for window shopping, to place signs, planters, or chairs.

STREET CLASSIFICATION	ENHANCEMENT ZONE/PARKING LANE	BUFFER ZONE	PEDESTRIAN THROUGH ZONE	FRONTAGE ZONE
Local Streets	Varies	4 - 6 ft	6 ft	N/A
Downtown and Pedestrian Priority Areas	Varies	4 - 6 ft	12 ft	2.5 - 10 ft
Arterials and Collectors	Varies	4 - 6 ft	6 - 8 ft	2.5 - 5 ft

Typical Uses

- Wider sidewalks should be installed near schools, at transit stops, in downtown areas, or anywhere high concentrations of pedestrians exist.
- At transit stops, an 8 ft by 5 ft clear space is required for accessible passenger boarding/alighting at the front door location per ADA requirements.
- Sidewalks should be continuous on both sides of urban commercial streets, and should be required in areas of moderate residential density (1-4 dwelling units per acre).
- When retrofitting gaps in the sidewalk network, locations near transit stops, schools, parks, public buildings, and other areas with high concentrations of pedestrians should be the highest priority.

Materials and Maintenance

Sidewalks are typically constructed out of concrete and are separated from the roadway by a curb or gutter and sometimes a landscaped boulevard. Less expensive walkways constructed of asphalt, crushed stone, or other stabilized surfaces may be appropriate. Ensure accessibility and properly maintain all surfaces regularly. Surfaces must be firm, stable, and slip resistant. Colored, patterned, or stamped concrete can add distinctive visual appeal.

Approximate Cost

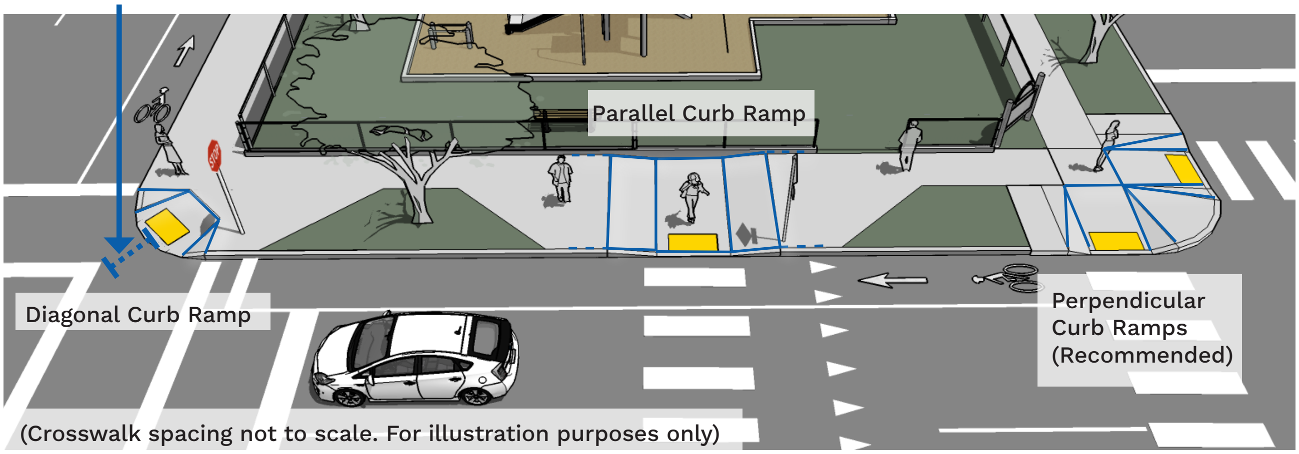
Cost of standard sidewalks range from about $25 per square foot for concrete sidewalk. This cost can increase with additional right-of-way acquisition or addition of landscaping, lighting or other aesthetic features. As an interim measure, an asphalt concrete path can be placed until such time that a standard sidewalk can be built. The cost of asphalt path can be less than half the cost of a standard sidewalk.

Curb Ramps

Curb ramps are the design elements that allow all users to make the transition from the street to the sidewalk. A sidewalk without a curb ramp can be useless to someone in a wheelchair, forcing them back to a driveway and out into the street for access. There are a number of factors to be considered in the design and placement of curb ramps.

Diagonal ramps shall include a clear space of at least 48" within the crosswalk for user maneuverability

Curb ramps shall be located so that they do not project into vehicular traffic lanes, parking spaces, or parking access aisles. Three configurations are illustrated below.



Typical Use

Curb ramps must be installed at all intersections and midblock locations where pedestrian crossings exist, as mandated by federal legislation (1973 Rehabilitation Act and ADA 1990). All newly constructed and altered roadway projects must include curb ramps. In addition, existing facilities must be upgraded to current standards when appropriate.

The edge of an ADA compliant curb ramp shall be marked with a tactile warning device (also known as truncated domes) to alert people with visual impairments to changes in the pedestrian environment. Contrast between the raised tactile device and the surrounding infrastructure is important so that the change is readily evident to partially sighted pedestrians. These devices are most effective when adjacent to smooth pavement so the difference is easily detected.

Design Features

- The level landing at the top of a ramp shall be at least 4 feet long and at least the same width as the ramp itself. The slope of the ramp shall be compliant to current standards.
- If the ramp runs directly into a crosswalk, the landing at the bottom will be in the roadway.
- If the top landing is within the sidewalk or corner area where someone in a wheelchair may have to change direction, the landing must be a minimum of 5'-0" long (in the direction of the ramp run) and at least as wide as the ramp, although a width of 5'-0" is preferred.

Materials and Maintenance

It is critical that the interface between a curb ramp and the street be maintained adequately. Asphalt street sections can develop potholes at the foot of the ramp, which can catch the front wheels of a wheelchair.

Approximate Cost

The cost is approximately $5,000-$10,000 per curb ramp depending on drainage and right-of-way.

Further Considerations

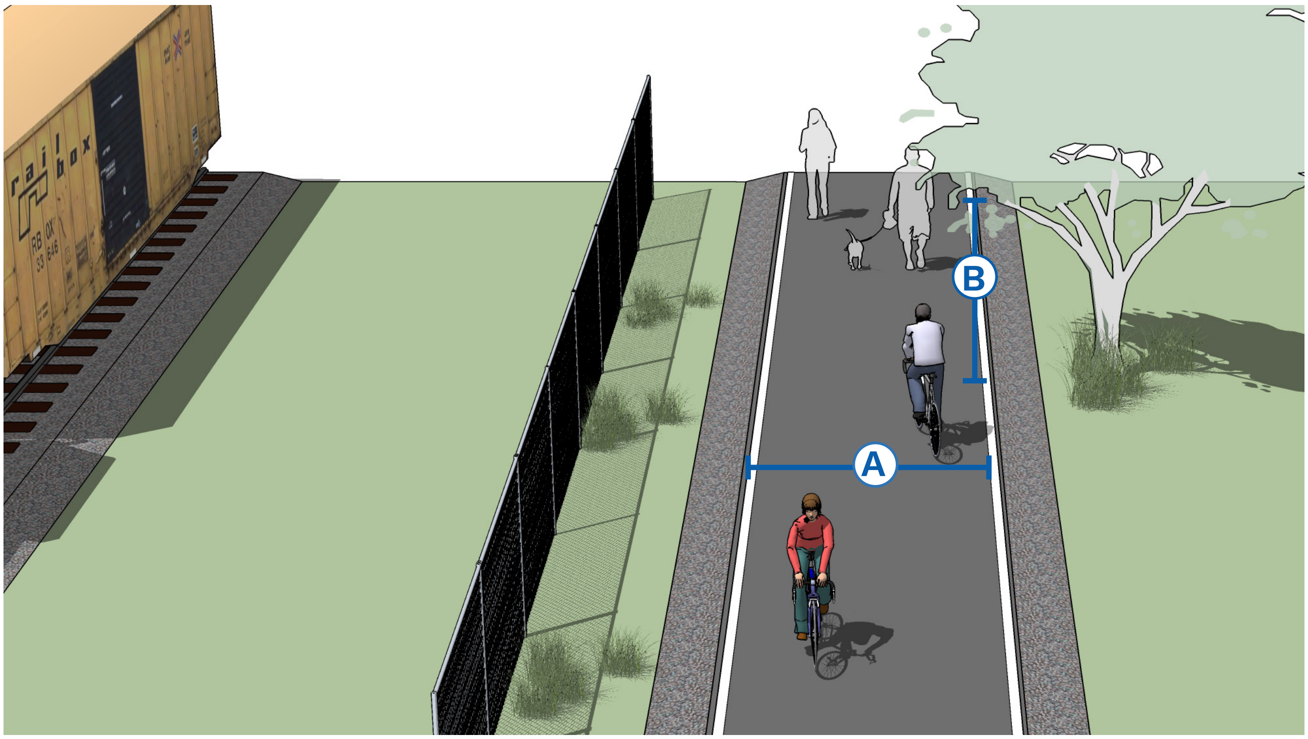
Where feasible, separate directional curb ramps for each crosswalk at an intersection should be provided rather than having a single ramp at a corner for both crosswalks. Although diagonal curb ramps might save money, they orient pedestrians directly into the traffic zone, which can be challenging for wheelchair users and pedestrians with visual impairment. Diagonal curb ramp configurations are not recommended.

Curb return radii meed to be considered when designing directional ramps. While curb ramps are needed for use on all types of streets, the highest priority locations are in downtown areas and on streets near transit stops, schools, parks, medical facilities, shopping areas.

CLASS I BIKEWAYS: BIKE PATHS

Class I Bikeway: Shared Use Path

A shared use path provides a travel area separate from motorized traffic for bicyclists, pedestrians, skaters, wheelchair users, joggers, and other users. Shared use paths are desirable for bicyclists of all skill levels preferring separation from traffic. Bicycle paths should generally provide directional travel opportunities not provided by existing roadways. Most shared use paths are designed for two-way travel.



Typical Use

- In waterway corridors, such as along canals, drainage ditches, rivers, and creeks.
- In abandoned rail corridors (commonly referred to as Rails-to-Trails or Rail-Trails.
- In active rail corridors, trails can be built adjacent to active railroads (referred to as Rails-with-Trails.
- In utility corridors, such as powerline and sewer corridors.
- Along roadways.

Design Features

- **A** 12 ft is recommended for heavy use situations with high concentrations of multiple users. A separate track (5' minimum) can be provided for pedestrian use.
- 10 ft is recommended in most situations and will be adequate for moderate to heavy use.
- 8 ft is the minimum width (with 2' ft shoulders) allowed for a two-way bicycle path and is only recommended for low traffic situations. (Caltrans Design Manual)

Lateral Clearance

- A 2 ft or greater shoulder on both sides of the path should be provided. An additional ft of lateral clearance (total of 3') is required by the CAMUTCD for the installation of signage or other furnishings.

Overhead Clearance

- **B** Clearance to overhead obstructions should be 8 ft minimum, with 10 ft recommended.

Striping

- » When striping is required, use a 4 inch dashed yellow centerline stripe with 4 inch solid white edge lines.
- » Solid centerlines can be provided on tight or blind corners and transitions, and on the approaches to roadway crossings.

Further Considerations

Under most conditions, centerline markings are not necessary. Centerline markings should only be used if necessary for clarifying user positioning or preferred operating procedure: Solid line = No Passing; Dashed line = Lane placement

Paths with a high volume of bidirectional traffic should include a centerline. This can help communicate that users should expect traffic in both directions and encourage users to travel on the right and pass on the left.

Where there is a sharp blind curve, painting a solid yellow line with directional arrows reduces the risk of head-on collisions.

Small scale signs should be used in path environments (CAMUTCD 9B.02).

Terminate the path where it is easily accessible to and from the street system, preferably at a trailhead, controlled intersection or at the beginning of a dead-end street.

Use of bollards should be avoided when possible. If bollards are used at intersections and access points, they should be colored brightly and/or supplemented with reflective materials to be visible at night.

Shared Use Paths along Levees

Waterway corridors are often ideally suited for shared use paths. The relatively clear, level surface of the top of a levee or canal provides an ideal location for a shared use path.

Typical Application

Along levees.

Design Features

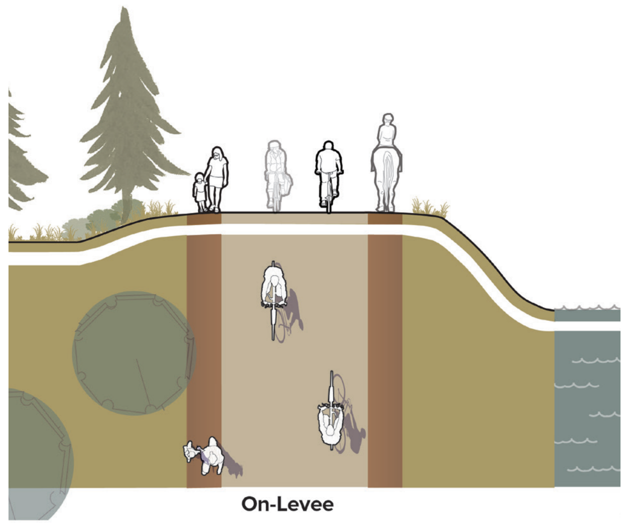
Shared use paths adjacent to levees or waterways should meet or exceed general design practices. If additional width allows, wider paths and landscaping are desirable.

Where the path is adjacent to levees, ditches, or slopes steeper than 1 vertical :3 horizontal (1:3), a wider separation should be considered. A 5-foot separation from the edge of the path to the top of slope is desirable under these circumstances. Where a slope of 1:2 or greater exists within 5 feet of a path and the fill is greater than 10 feet, a physical barrier such as dense shrubbery, railing, or chain link fence should be provided along the top of slope.

Access to a trail on top of a levee would likely require ramps or boardwalk to provide ADA compliance.

Public access to levees may be undesirable. Hazardous materials, deep water or swift current, steep, slippery slopes, and debris all may constitute risks for public access. Appropriate fencing may be desired to keep path users within the designated travel way. Creative design of fencing is encouraged to make the path facility feel welcoming to the user.

Any access point to the path should be well-defined with appropriate signage designating the pathway as a bicycle facility and prohibiting motor vehicles.



On-Levee

Further Considerations

It is not desirable to place the pathway in a narrow corridor between two fences for long distances, as this creates personal security issues, prevents users who need help from being seen, prevents path users from leaving the path in an emergency, and impedes emergency response. (AASHTO Bike Guide p.5-6)

Public access to the shared use path may be prohibited during the following events:

- Levee maintenance activities
- Inclement weather or the prediction of storm conditions

Shared Use Paths along Ditches & Drains

The corridors created by ditches and drains offer excellent shared use path development and bikeway gap closure opportunities. They are typically long and linear in nature and can generally offer a continuous pathway with few conflicts with other transportation modes.

Typical Application

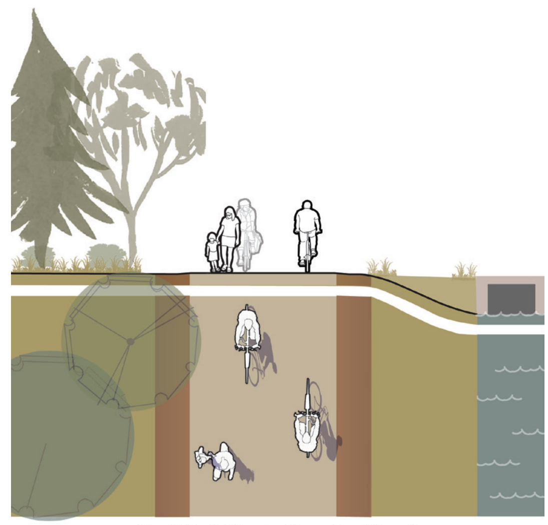
Along flood control channels such as ditches and drains.

Design Features

Shared use paths adjacent to waterways should meet or exceed general design practices. If additional width allows, wider paths and landscaping are desirable.

Public access to flood control channels may be undesirable. Hazardous materials, deep water or swift current, steep, slippery slopes, and debris all may constitute risks for public access. Appropriate fencing may be desired to keep path users within the designated travel way. Creative design of fencing is encouraged to make the path facility feel welcoming to the user.

Any access point to the path should be well-defined with appropriate signage designating the pathway as a bicycle facility and prohibiting motor vehicles.



On-Ditch/Drain Service Road

Further Considerations

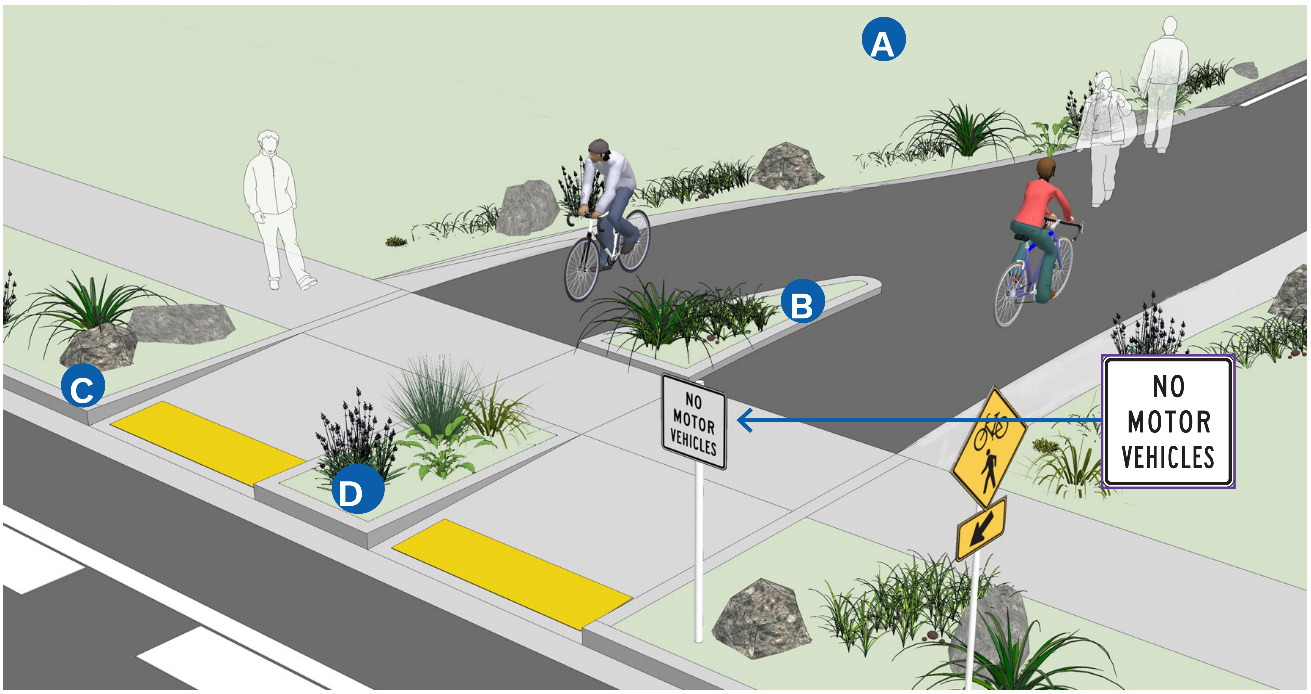
It is not desirable to place the pathway in a narrow corridor between two fences for long distances, as this creates personal security issues, prevents users who need help from being seen, prevents path users from leaving the path in an emergency, and impedes emergency response. (AASHTO Bike Guide p.5-6)

Public access to the shared use path may be prohibited during the following events:

- Flood control channel maintenance activities
- Inclement weather or the prediction of storm conditions

Bollard Alternatives

Bollards are physical barriers designed to restrict motor vehicle access to the multi-use path. Unfortunately, physical barriers are often ineffective at preventing access, and create obstacles to legitimate trail users. Alternative design strategies use signage, landscaping and curb cut design to reduce the likelihood of motor vehicle access.



Typical Application

- Bollards or other barriers should not be used unless there is a documented history of unauthorized intrusion by motor vehicles.
- If unauthorized use persists, assess whether the problems posed by unauthorized access exceed the risks and issues posed by bollards and other barriers.

Design Features

A "No Motor Vehicles" signage (R5-3) may be used to reinforce access rules.

B At intersections, split the path tread into two sections separated by low landscaping.

C Vertical curb cuts should be used to discourage motor vehicle access.

D Low landscaping preserves visibility and emergency access.

Screening/Barrier Separation Types

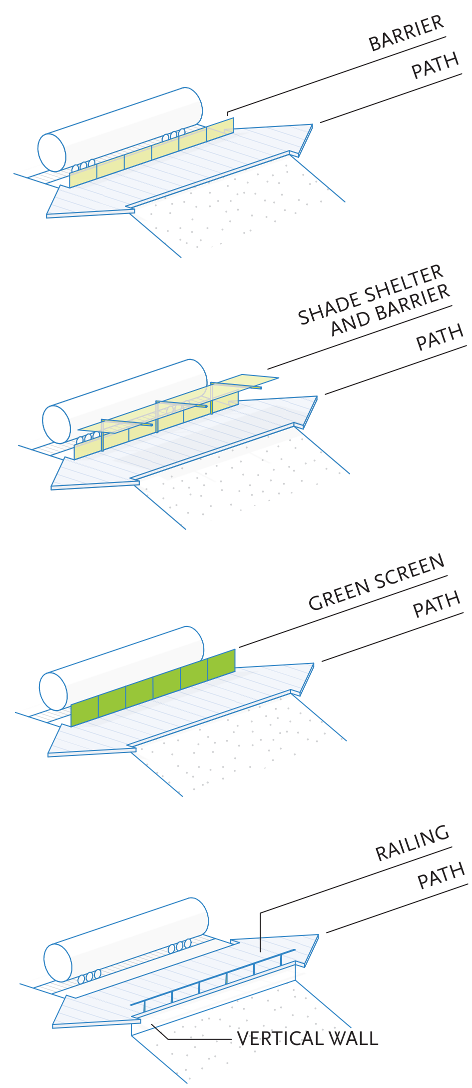
Urban trails typically transverse through a range of channel configurations, path types, and adjacent land uses. As a result, a toolkit of options is required in order to apply appropriate edge conditions to the unique circumstances along the path. Edge conditions comprise the range of treatments used to transition from the path of travel to space adjacent to the path. Edge conditions include shoulder buffers, screening, barriers, railing, and other visual and tactile cues to indicate the path of travel.[1] These treatments keep users from venturing off the path, protect users from hazards, delineate the path of travel where users are separated by direction, mode or speed, and enhance the comfort and attractiveness of the pathway.

Design Features

Shoulders should be a minimum of 2 feet wide 3 feet preferred) and constructed of the same material as the path or another durable surface.2 Shoulders should be sloped at 2% to 5% away to reduce ponding and minimize debris on the path.2 Three feet minimum is required where signage or other furnishings will be installed.3 A shoulder of at least 1 foot should be provided between the path and any fencing or barrier. Where the shoulder serves as a pedestrian path, a maximum cross slope of 2% is required to remain compliant with ADA regulations.

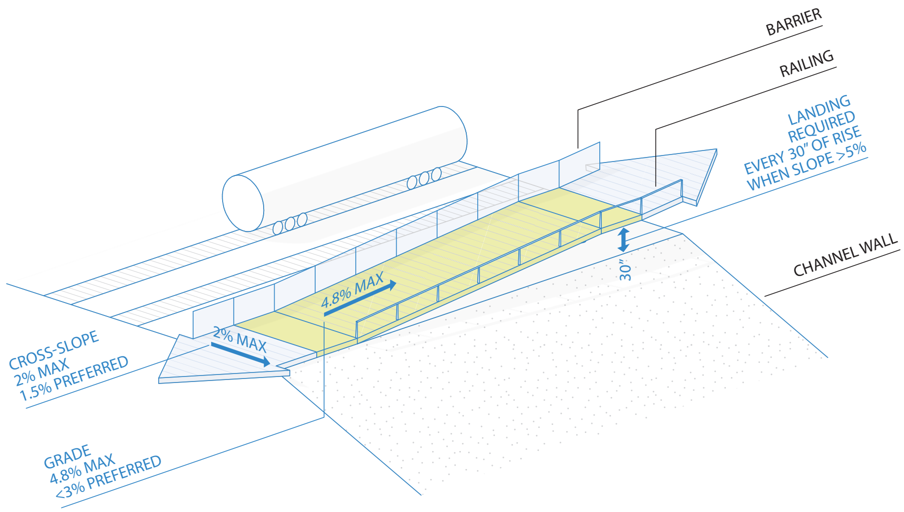
BARRIERS AND RAILINGS

Fences, walls, and railings will likely be a recurring element along the path to provide separation between the path and the channel edge, rail lines, and private property. In some areas, railings and/ or security fences will be on both sides of the path. For overcrossing structures, barrier and fence types are prescribed by Caltrans (e.g. Type 26 and Type 732 barriers)2.



Ramps

Many urban trails with connections to the on-street network feature extensive vertical transitions and ramping due to the existing conditions of the corridor. A common example is having to pass over/ under an existing road or to ramp over adjacent rail lines to connect to an access point. At other locations it may be necessary to ramp up or down depending on the presence of physical obstacles, such as utility towers or existing structures. Vertical transitions are also necessary to satisfy minimum vertical clearance requirements for overcrossings and undercrossings.

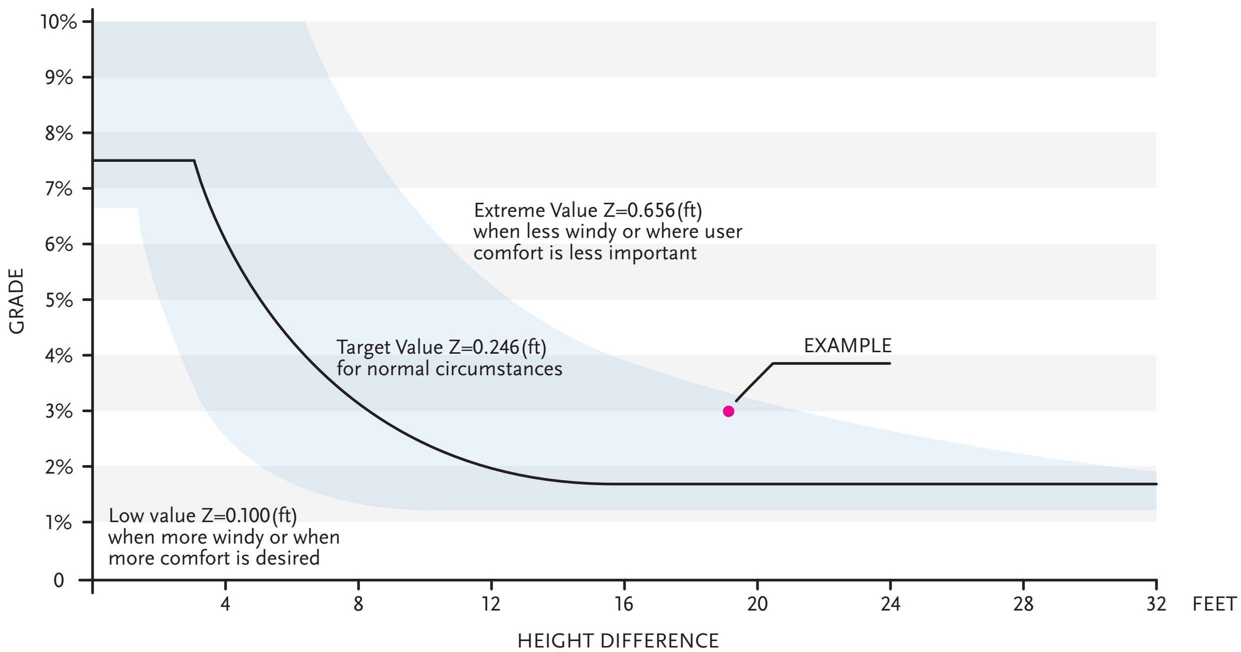


Design Features

The complexity of ramp design and construction will vary depending on the grade change, physical location of access points, the scale and orientation of path connectors, the proximity to competing structures (horizontal and vertical clearances), and budget. Compact ramp designs feature both horizontal and vertical transitions to facilitate comfortable transitions in constrained spaces. These include U-, S-, or Z-shaped ramps and spiraled ramps.

SLOPE/GRADE

Running slopes under 5% are typically employed along pathways as they do not qualify as a ramp and therefore are not subject to the ramp requirements set forth by ADAAG. Slopes of 4.8% are generally employed to account for inconsistencies in the construction process and ensure slopes do not exceed 5%. For ramps, the Slope Bandwidth formula1 can be used to evaluate the relationship between factors such as average slope, elevation change, wind level, and user comfort. It is assumed that the longer and steeper a ramp, the more difficult path users will find it to traverse. A cross slope of 1.5% is preferred for drainage and accessibility, but may go up to 2% in constrained conditions.



However, the average slope of a ramp impacts user comfort significantly more than ramp length. The difficulty the user experiences while using a ramp can be calculated as the square of the average slope multiplied by its length, formulated as:

Z = (H/L)2 x L = H2/L

or as the square of the height difference divided by its length, formulated as:

G = H/L = Z/H

where H = elevation change, L = length,

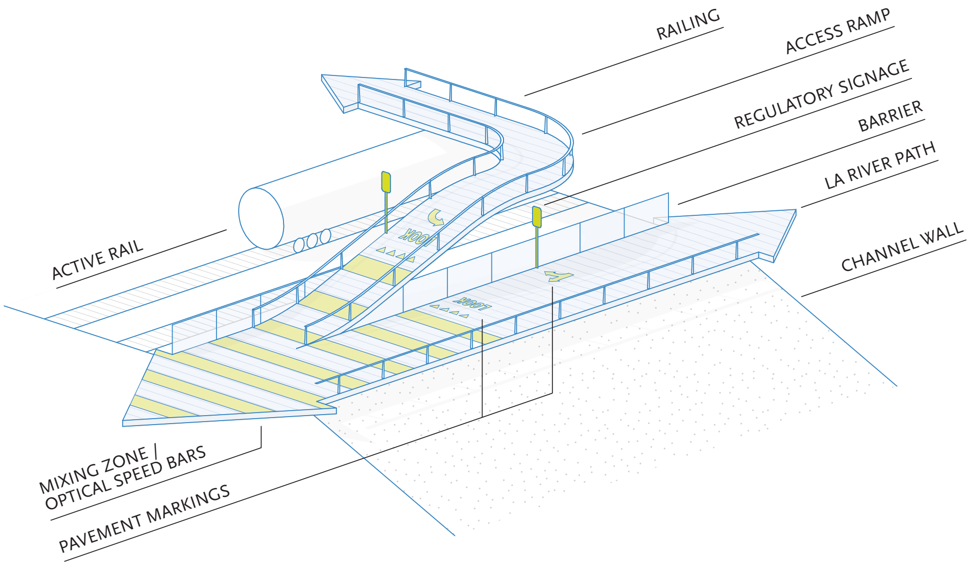
G = average slope, Z = difficulty for users.

The Slope Bandwidth graph shows that target ramp slopes that are believed to be comfortable for the average person bicycling should be between 1.75% and 7.5%. The lower limit slope is between 1.25% and 6.67% and the upper limit maximum slope is 10%. The steeper the slope, the shorter the distance it may be employed to maintain the same relative level of ease or difficulty to the user.

1 Dutch Design Manual for Bicycle and Pedestrian Bridges ipv Delft, 2015
Additional Resources
Caltrans HDM, 200, 300
UPRR and BNSF Guidelines for Railroad Grade Separation Projects, 4, 5
SCRRA Grade Separation Guidelines, 7

Path Transitions

Transitions occur where the path meets a roadway or railway, where one path typology meets another, such as when an elevated path transitions into an at-grade path or where separated path segments transition into shared environments. Transitions may also include horizontal shifts to avoid physical obstacles such as utility towers or other structures.



Design Features

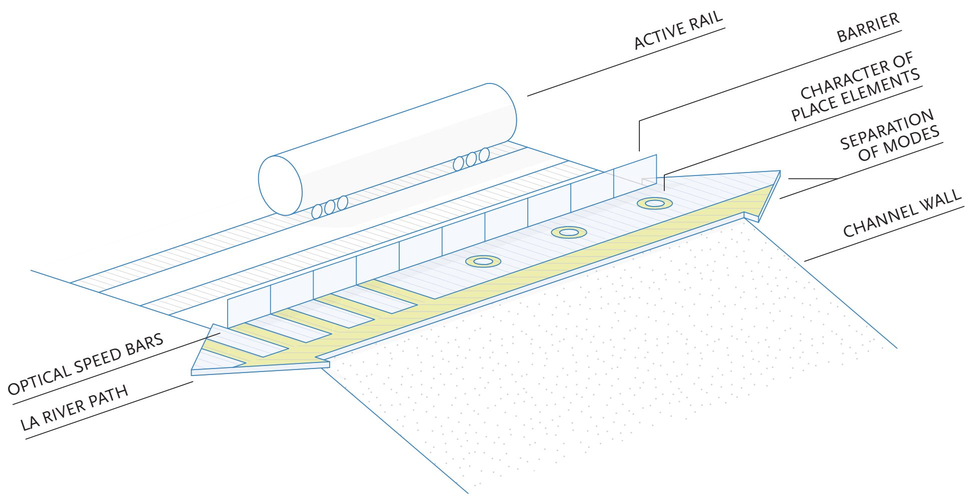
TYPOLOGY TRANSITIONS

Design elements used to alert path users include pavement markings such as optical speed bars, zebra stripe crosswalks with yield/stop markings, and “LOOK” legends and arrows. Other visual indications include bike and pedestrian directional markings, centerlane striping, and the use of colored pavement to visually narrow or indicate a change in environment.

Tactile indications include speed humps, tactile speed bars, and the use of multiple surface types, such as concrete, asphalt, and pavers.

Advisory, regulatory, and/or wayfinding signage are should be considered at transition points. Physical treatments to alert and guide path users include traffic calming measures such as vertical and horizontal deflection.

Path Illumination is an important design element that must be considered along the path, but is especially important in transition zones.



MIXING ZONES

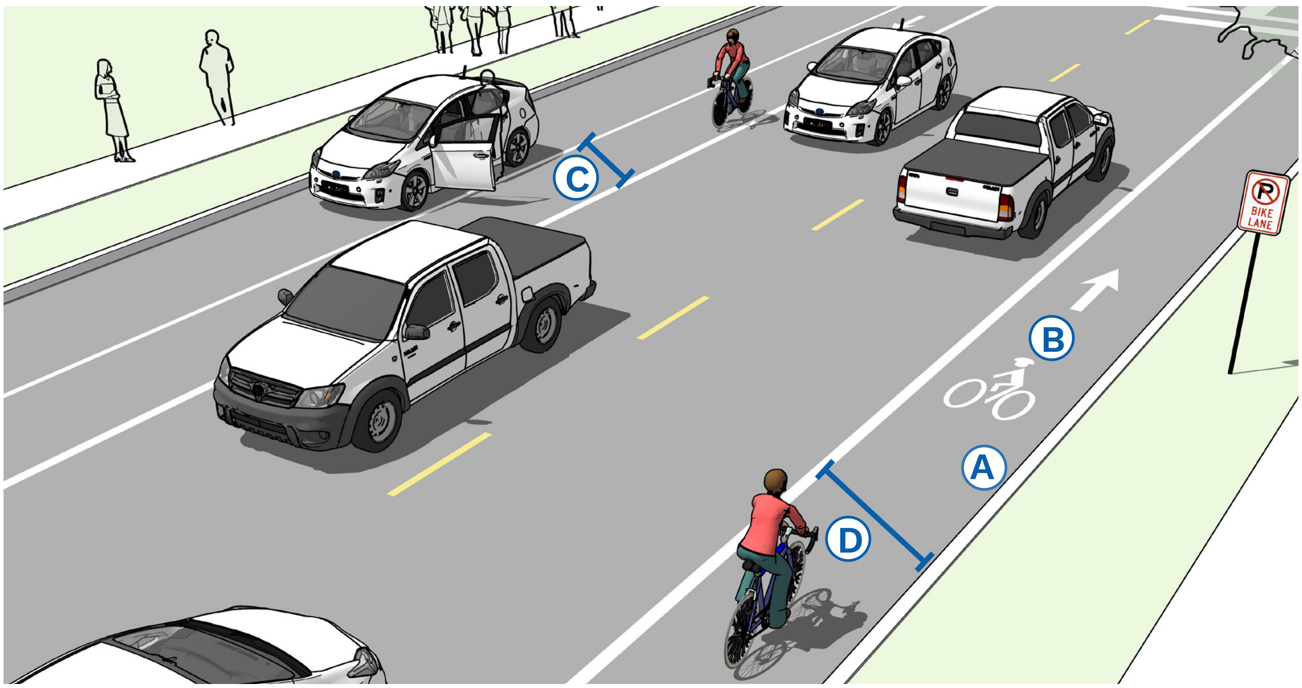
Mixing zones are necessary where physical space constraints do not allow for separated modes, or at locations along the path where a high level of cross-traffic is expected. Mixing zones need to provide clear indication to all users that a transition is occurring in advance of the change, so that path users can adjust their speeds and awareness appropriately to proceed carefully into the mixing zone (see Path Fundamentals: Sight Distances).

Advanced warning can be accomplished with advisory signage, pavement markings, and the use of contrasting surface treatments (e.g. pavers/inlays with contrasting tones/textures, striping, or a combination of these treatments). These design elements help to guide path users safely through the mixing zone by alerting users to the change in conditions and thus reducing the speed differential.

CLASS II BIKEWAYS: BIKE LANES

Class II Bikeways: Bicycle Lanes

On-street bike lanes (Class II Bikeways) designate an exclusive space for bicyclists through the use of pavement markings and signs. The bike lane is located directly adjacent to motor vehicle travel lanes and is used in the same direction as motor vehicle traffic. Bike lanes are typically on the right side of the street, between the adjacent travel lane and curb, road edge or parking lane.



Typical Use

- Bike lanes may be used on any street with adequate space, but are most effective on streets with moderate traffic volumes ≥ 6,000 ADT (≥ 3,000 preferred).
- Bike lanes are most appropriate on streets with lower to moderate speeds ≥ 25 mph.
- Appropriate for skilled adult riders on most streets.
- May be appropriate for children when configured as 6+ ft wide lanes on lower-speed, lower-volume streets with one lane in each direction.

Design Features

A Mark inside line with 6" stripe. (CA MUTCD 9C.04) Mark 4" parking lane line or "Ts".1

B Include a bicycle lane marking (CA MUTCD Figure 9C-3) at the beginning of blocks and at regular intervals along the route. (CA MUTCD 9C.04)

C 6 foot width preferred adjacent to on-street parking, (5 foot min.)

D 5–6 foot preferred adjacent to curb and gutter (4 foot min.) or 4 feet more than the gutter pan width.

~~1 Studies have shown~~ that marking the parking lane encourages people to park closer to the curb. FHWA. Bicycle Countermeasure Selection System. 2006.

Further Considerations

On high speed streets (≥ 40 mph) the minimum bike lane should be 6 feet. (HDM 301.2)

It may be desirable to reduce the width of general purpose travel lanes in order to add or widen bicycle lanes. (HDM 301.2 3)

On multi-lane streets, the most appropriate bicycle facility to provide for user comfort may be buffered bicycle lanes or physically separated bicycle lanes.

MANHOLE COVERS AND GRATES:

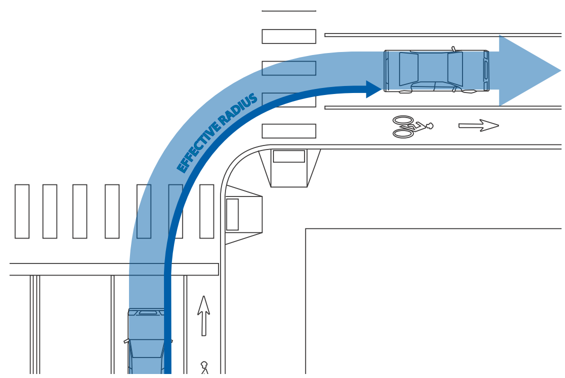
- Manhole surfaces should be manufactured with a shallow surface texture in the form of a tight, nonlinear pattern
- If manholes or other utility access boxes are to be located in bike lanes within 50 ft. of intersections or within 20 ft. of driveways or other bicycle access points, special manufactured permanent nonstick surfaces are required to ensure a controlled travel surface for cyclists breaking or turning.
- Manholes, drainage grates, or other obstacles should be set flush with the paved roadway. Roadway surface inconsistencies pose a threat to safe riding conditions for bicyclists. Construction of manholes, access panels or other drainage elements should be constructed with no variation in the surface. The maximum allowable tolerance in vertical roadway surface will be 1/4 of an inch.

Materials and Maintenance

Bike lane striping and markings will require higher maintenance where vehicles frequently traverse over them at intersections, driveways,

Standard Class II Bike Lane

PLACE BIKE LANE SYMBOLS TO REDUCE WEAR



Bike lane word, symbol, and/or arrow markings (CAMUTCD Figure 9C-3) shall be placed outside of the motor vehicle tread path in order to minimize wear from the motor vehicle path. (NACTO 2012)

parking lanes, and along curved or constrained segments of roadway.

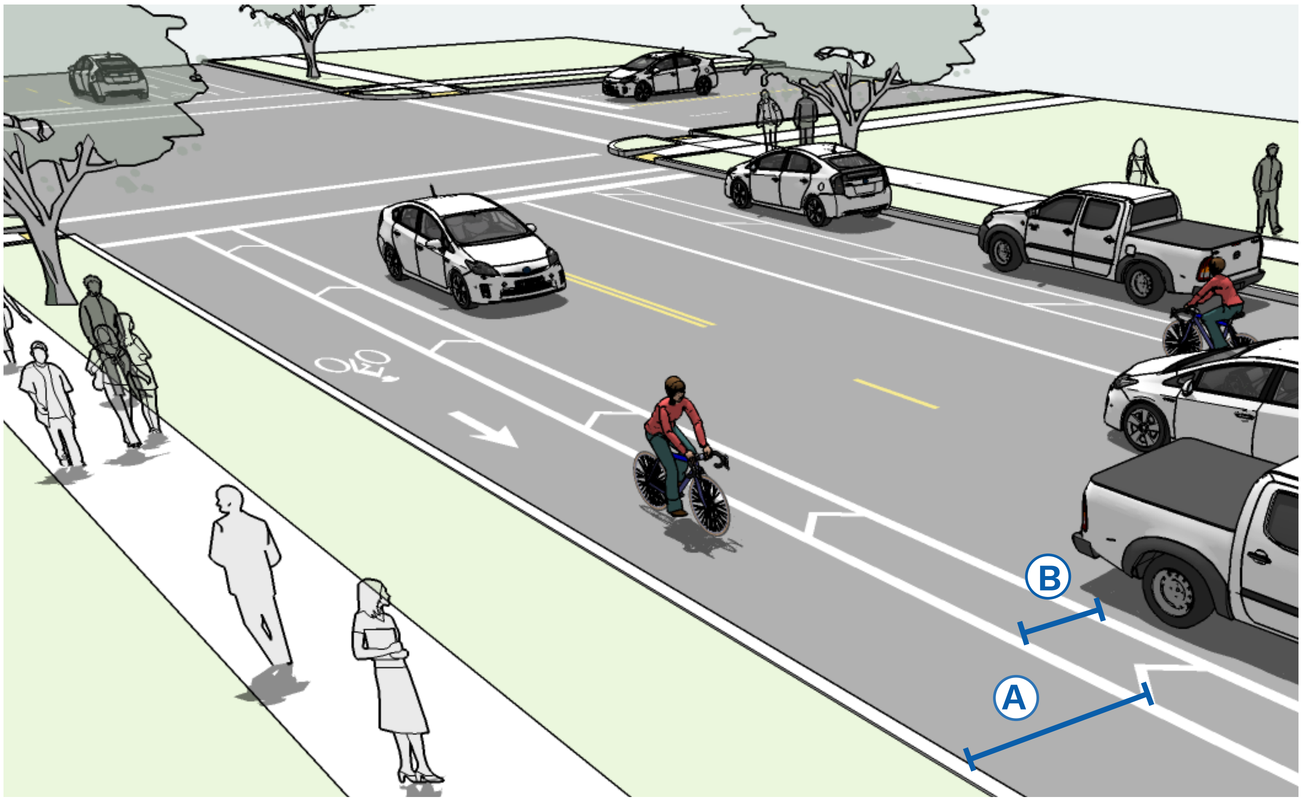
Bike lanes should also be maintained so that there are no pot holes, cracks, uneven surfaces or debris.

Approximate Cost

The cost for installing bicycle lanes will depend on the implementation approach. Typical costs are $80,000 per mile for restriping bike lanes on both sides of the road.

Class II Bikeways: Buffered Bicycle Lanes

Buffered bike lanes are conventional bicycle lanes paired with a striped buffer space, separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane.



Typical Use

- Anywhere a conventional bike lane is being considered.
- While conventional bike lanes are most appropriate on streets with lower to moderate speeds (≥ 25 mph), buffered bike lanes are appropriate on streets with higher speeds (+25mph) and high volumes or high truck volumes (up to 6,000 ADT).
- On streets with extra lanes or lane width.
- Appropriate for skilled adult riders on most streets.

Design Features

(A) The minimum bicycle travel area (not including buffer) is 5 feet wide.

(B) Buffers should be at least 2 feet wide. If buffer area is 4 feet or wider, white chevron or diagonal markings should be used. **(CA MUTCD 9C-104)**

- For clarity at driveways or minor street crossings, consider a dotted line.
- There is no standard for whether the buffer is configured on the parking side, the travel side, or a combination of both.

Buffered bike lane transitions into dotted green and white lane markings to indicate conflict point

The use of pavement markings delineates space for cyclists to ride in a comfortable facility.

Further Considerations

- Color may be used within the lane to discourage motorists from entering the buffered lane.
- A study of buffered bicycle lanes found that, in order to make the facilities successful, there needs to also be driver education, improved signage and proper pavement markings.[1]
- On multi-lane streets with high vehicles speeds, the most appropriate bicycle facility to provide for user comfort may be physically separated bike lanes.
- NCHRP Report #766 recommends, when space in limited, installing a buffer space between the parking lane and bicycle lane where on-street parking is permitted rather than between the bicycle lane and vehicle travel lane.[2]

1 *Monsere, C.; McNeil, N.; and Dill, J., "Evaluation of Innovative Bicycle Facilities: SW Broadway Cycle Track and SW Stark/Oak Street Buffered Bike Lanes. Final Report" (2011).Urban Studies and Planning Faculty Publications and Presentations.*

2 *National Cooperative Highway Research Program. Report #766: Recommended Bicycle Lane Widths for Various Roadway Characteristics.*

Materials and Maintenance

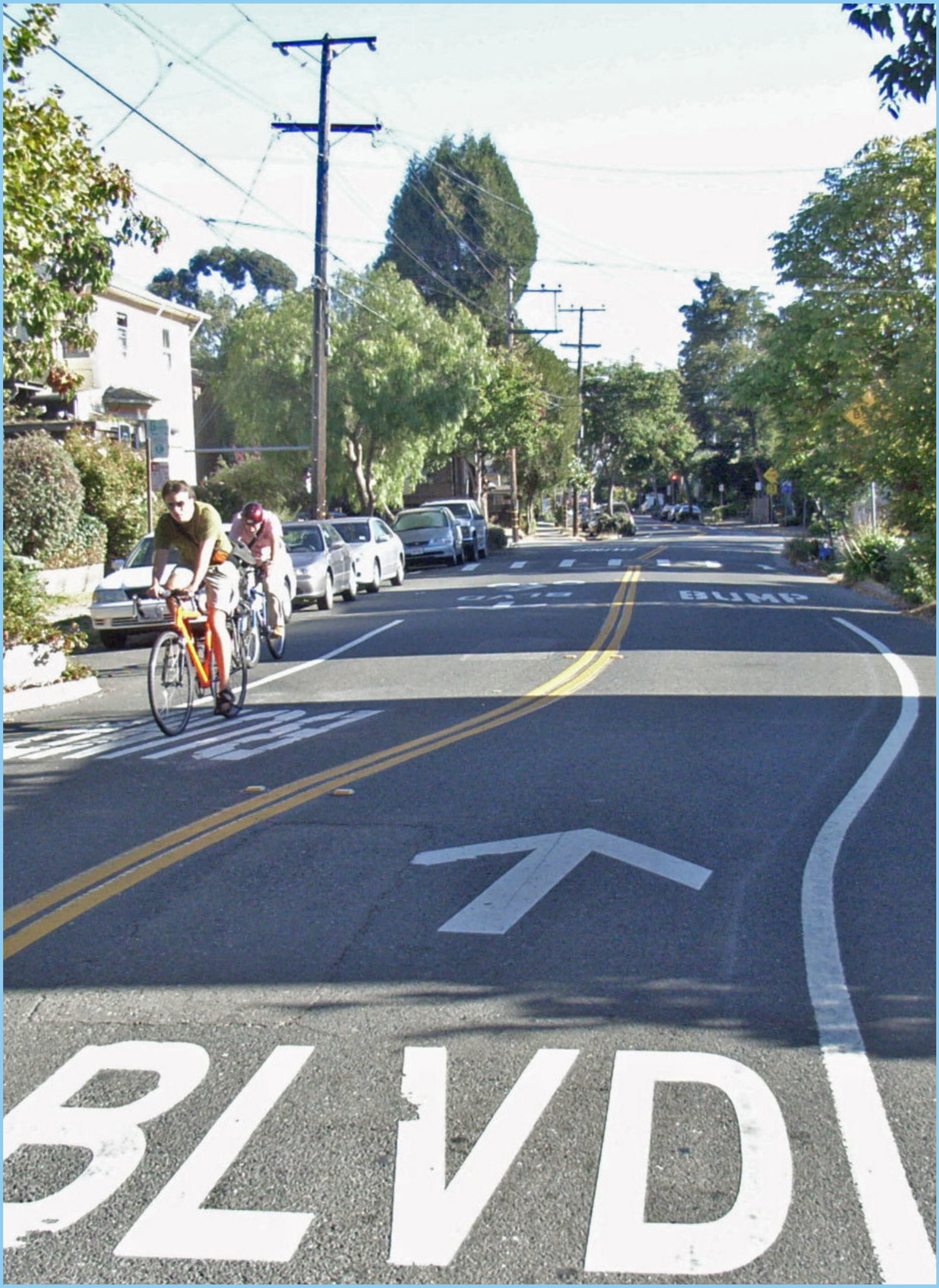
Bike lane striping and markings will require higher maintenance where vehicles frequently traverse over them at intersections, driveways, parking lanes, and along curved or constrained segments of roadway.

Bike lanes should be maintained so that there are no pot holes, cracks, uneven surfaces or debris.

Approximate Cost

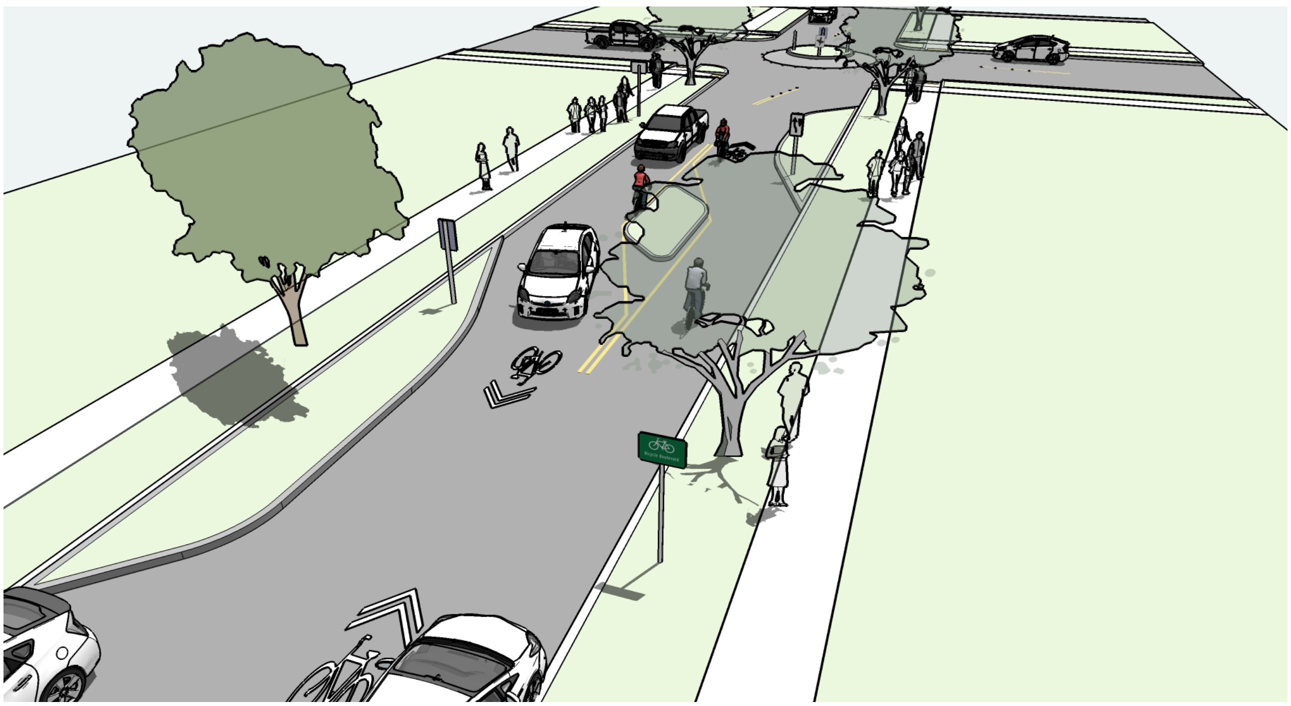
The cost for installing buffered bicycle lanes will depend on the implementation approach. Typical costs are a $80,000 to $425,000 per mile. However, the cost of large-scale bicycle treatments will vary greatly due to differences in project specifications and the scale and length of the treatment.

CLASS III BIKEWAYS: BIKE ROUTES


BUMP
BLVD

Class III Bikeway: Bicycle Boulevard

A Bicycle Boulevard is a low-speed, low-volume roadway that has been modified, as needed, to enhance comfort and convenience for people bicycling. It provides better conditions for bicycling while maintaining the neighborhood character and neighborhood and emergency vehicle access. Bicycle Boulevards are intended to serve as the primary low-stress bikeway network, providing direct, and convenient routes across Milpitas. Key elements of Bicycle Boulevards are unique signage and pavement markings, traffic calming and diversion features to maintain low vehicle volumes, and convenient major street crossings.



Typical Use

- Parallel with, and in close proximity to major thoroughfares (1/4 mile or less) on low-volume, low-speed streets.
- Follow a desire line for bicycle travel that is ideally long and relatively continuous (2-5 miles).
- Avoid alignments with excessive zigzag or circuitous routing. The bikeway should have less than 10% out of direction travel compared to shortest path of primary corridor.
- Local streets with traffic volumes of fewer than 1,500 vehicles per day. Utilize traffic calming to maintain or establish low volumes and discourage vehicle cut through / speeding.

Design Features

- » Signs and pavement markings are the minimum treatments necessary to designate a street as a bicycle boulevard.
- » Implement volume control treatments based on the context of the bicycle boulevard, using engineering judgment. Motor vehicle volumes should not exceed 1,500 vehicles per day.
- » Intersection crossings should be designed to enhance comfort and minimize delay for bicyclists, following crossing treatment progression to achieve Level of Traffic Stress 1 or 2.

Further Considerations

- » Bicycle boulevards are established on streets that improve connectivity to key destinations and provide a direct, low-stress route for bicyclists, with low motorized traffic volumes and speeds, designated and designed to give bicycle travel priority over other modes.
- » Bicycle boulevard retrofits to local streets are typically located on streets without existing signalized accommodation at crossings of collector and arterial roadways. Without treatments for bicyclists, these intersections can become major barriers along the bicycle boulevard.

- » Traffic calming can deter motorists from driving on a street. Anticipate and monitor vehicle volumes on adjacent streets to determine whether traffic calming results in inappropriate volumes. Traffic calming can be implemented on a trial basis.

Materials and Maintenance

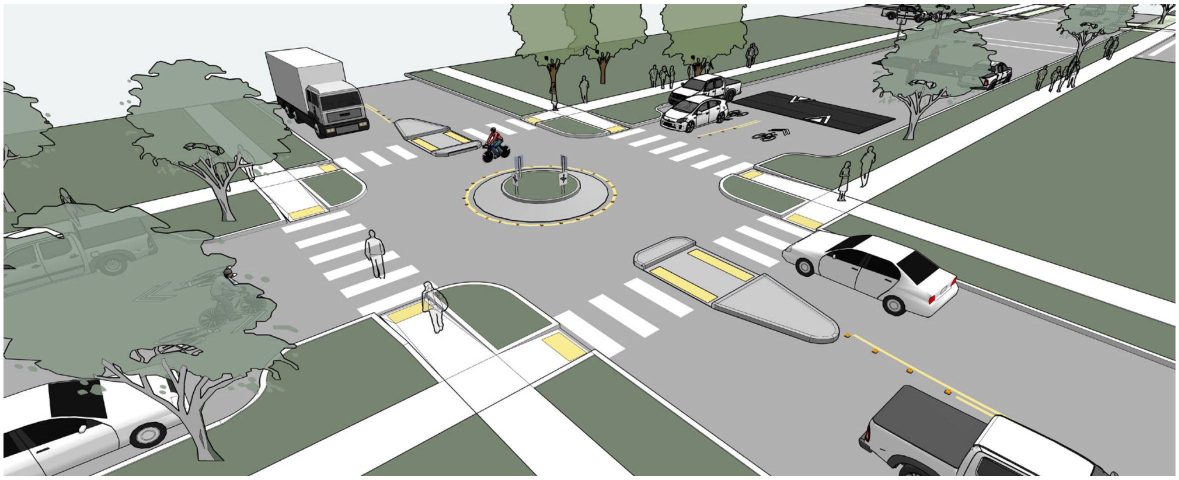
Bicycle boulevards require few additional maintenance requirements to local roadways. Signage, signals, and other traffic calming elements should be inspected and maintained according to local standards.

Approximate Cost

Costs vary depending on the type of treatments proposed for the corridor. Simple treatments such as wayfinding signage and markings are most cost-effective, but more intensive treatments will have greater impact at lowering speeds and volumes, at higher cost. Costs can range from $75,000/mile on the simple end to $140,000/mile for significant horizontal deflection and diversion.

Class III Bikeway: Traffic Calming

Traffic calming devices cause drivers to slow down by constricting the roadway space or by requiring careful maneuvering. Such measures may reduce the design speed of a street, and can be used in conjunction with reduced speed limits to reinforce the expectation of lowered speeds.



Application

- Neighborhood bikeways should have a maximum posted speed of 25 mph. Use traffic calming to maintain an 85th percentile speed below 22 mph.
- Maintain a minimum clear width of 14 feet with a constricted length of at least 20 feet in the direction of travel.
- Horizontal speed control measures should not infringe on bicycle space. Where possible, provide a bicycle route outside of the element so bicyclists can avoid having to merge into traffic at a narrow pinch point.
- Horizontal traffic calming devices cause drivers to slow down by constricting the roadway space or by requiring careful maneuvering. Such measures may reduce the design speed of a street, and can be used in conjunction with reduced speed limits to reinforce the expectation of lowered speeds.

Design Features

VERTICAL TRAFFIC CALMING

- Speed humps are raised areas usually placed in a series across both travel lanes. A 14’ long hump reduces impacts to emergency vehicles. Speed humps can be challenging for bicyclists, gaps can be provided in the center or by the curb for bicyclists and to improve drainage. Speed humps can also be offset to accommodate emergency vehicles.
- Speed lumps or cushions have gaps to accommodate the wheel tracks of emergency vehicles.
- Speed tables are longer than speed humps and flat-topped. Raised crosswalks are speed tables that are marked and signed for a pedestrian crossing.
- For all vertical traffic calming, slopes should not exceed 1:10 or be less steep than 1:25. Tapers should be no greater than 1:6 to reduce the risk of bicyclists losing their balance. The vertical lip should be no more than a 1/4” high.

Speed hump with traffic circle sign.

HORIZONTAL TRAFFIC CALMING

- Maintain a minimum clear width of 20 feet (or 28 feet with parking on both sides), with a constricted length of at least 20 feet in the direction of travel.
- Chicanes are a series of raised or delineated curb extensions, edge islands, or parking bays on alternating sides of a street forming an "S"-shaped curb, which reduce vehicle speeds by requiring motorists to shift laterally through narrowed travel lanes.
- Pinchponts are curb extensions placed on both sides of the street, narrowing the travel lane and encouraging all road users to slow down. When placed at intersections, pinchpoints are known as chokers or neckdowns. They reduce curb radii and further lower motor vehicle speeds.
- Traffic circles are raised or delineated islands placed at intersections that reduce vehicle speeds by narrowing turning radii and the travel lane. Traffic circles can also include a paved apron to accommodate the turning radii of larger vehicles like fire trucks or school buses.

Further Consideration

- Benefits of speed management include:
- Improves conditions for bicyclists, pedestrians, and residents along the neighborhood bikeway.
- Reduced travel speeds decrease the number of passing events between bicyclists and motor vehicles, reducing exposure risks.
- Reduced travel speeds result in reduced injury severity in the event of a collision.
- Emergency vehicle response times should be considered where vertical deflection is used. Because emergency vehicles have a wider wheel base than passenger cars, speed lumps/cushions allow them to pass unimpeded while slowing most other traffic.

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Litman, T. (1999). Traffic Calming Benefits, Costs, and Equity Impacts.
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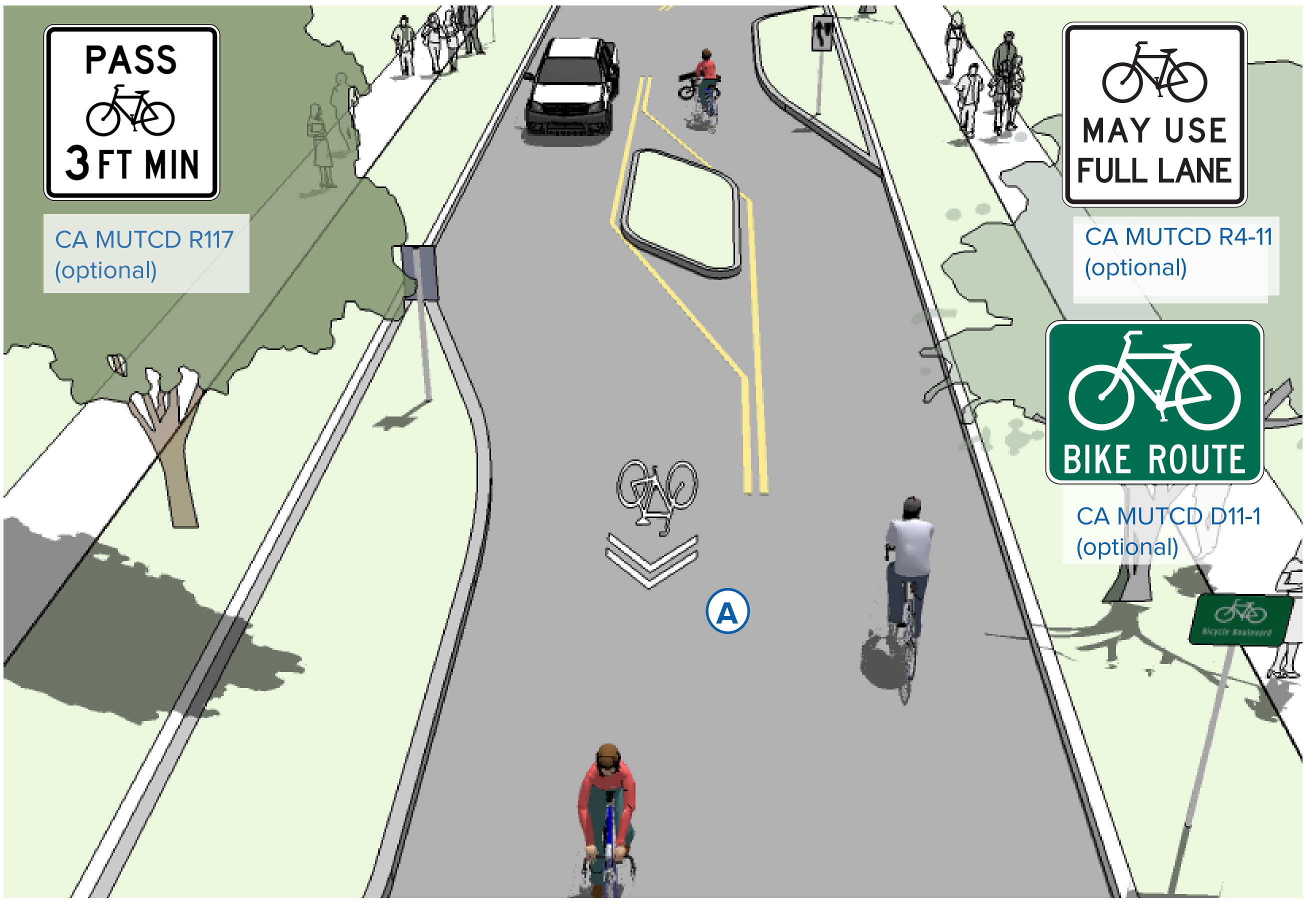
Class III Bikeway: Shared Lane Markings

Shared Lane Marking (SLM) or "Sharrow" stencils are used in California as an additional treatment for Bike Route facilities and are currently approved in conjunction with on-street parking. The CA MUTCD approved pavement marking can serve a number of purposes, such as making motorists aware of the need to share the road with bicyclists, showing bicyclists the direction of travel, and, with proper placement, reminding bicyclists to bike further from parked cars to prevent collisions with drivers opening car doors.



Typical Use

- Shared Lane Markings are not appropriate on paved shoulders or in bike lanes, and should not be used on roadways that have a posted speed greater than 35 mph.
- Shared Lane Markings should be implemented in conjunction with BIKES MAY USE FULL LANE signs (R4-11).

Design Features

(A) Placement in the center of the travel lane is preferred in constrained conditions.

- Markings should be placed immediately after intersections and spaced at 250 foot intervals thereafter.
- When placed adjacent to parking, markings should be outside of the "door zone". Minimum placement is 11 feet from the curb face.

Sharrows also serve as positional guidance and raise bicycle awareness where there isn't space to accommodate a full-width bike lane. Center lane markings may or may not be necessary depending on travel lane widths. Narrower two way residential streets (less than 22 ft between parked cars) have a natural traffic calming effect without center turn lanes.

Further Considerations

Consider modifications to signal timing to induce a bicycle-friendly travel speed for all users.

Though not always possible, placing the markings outside of vehicle tire tracks will increase the life of the markings and the long-term cost of the treatment.

A green thermoplastic background can be applied to further increase the visibility of the shared lane marking.

A "Pass Bicycle 3 FT MIN" sign (R117(CA)) can be installed to indicate to drivers the required passing distance per California Vehicle Code section 21760.

Materials and Maintenance

Shared lane markings should be inspected annually and maintained accordingly, especially if located on roadways that feature high vehicle turning movements, or bus, or truck traffic. They can be placed in the center of the lane of travel to reduce wear from vehicles.

Approximate Cost

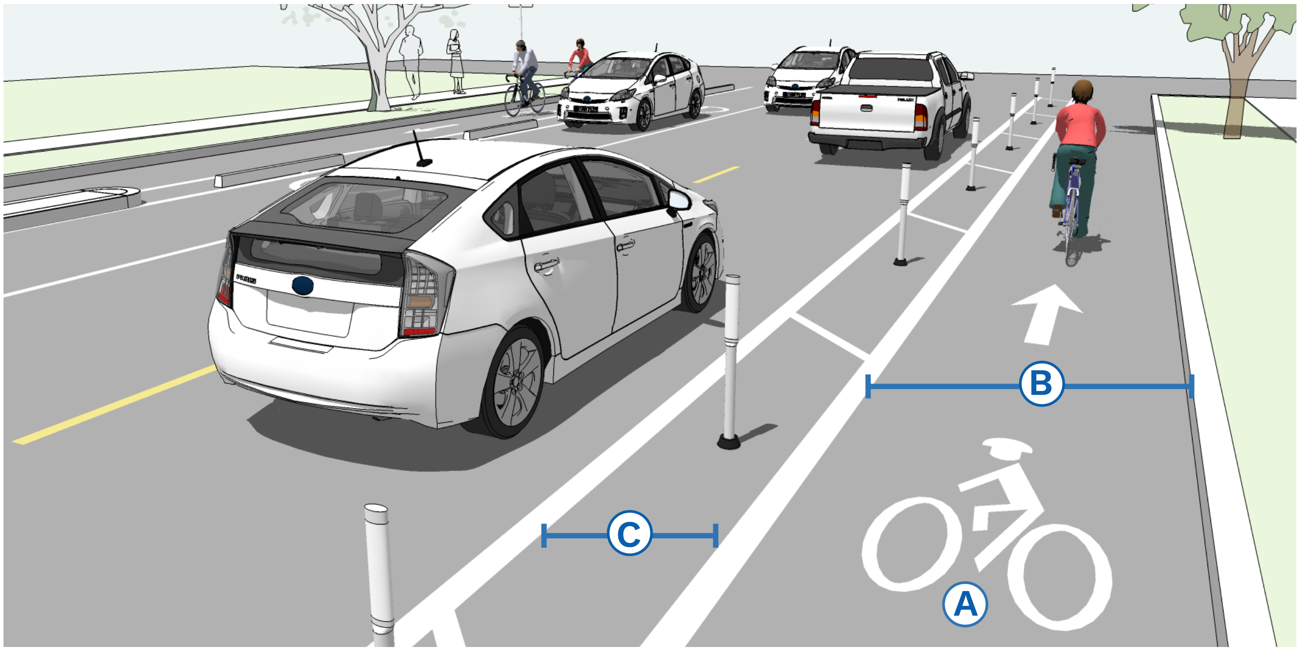
Sharrows typically cost $200 per each marker for a lane-mile cost of $4,200, assuming the CA MUTCD guidance of sharrow placement every 250 feet in each direction.

CLASS IV BIKEWAYS: PROTECTED BIKE LANES


Civic Center
T Way
EMERGENCY
25

Class IV Bikeway: One-Way Separated

One-way separated bikeways, also known as protected bikeways or cycle tracks, are on-street bikeway facilities that are separated from vehicle traffic. Physical separation is provided by a barrier between the bikeway and the vehicular travel lane. These barriers can include flexible posts, bollards, parking, planter strips, extruded curbs, or on-street parking. Separated bikeways using these barrier elements typically share the same elevation as adjacent travel lanes, but the bikeway could also be raised above street level, either below or equivalent to sidewalk level.



Typical Use

- Along streets on which conventional bicycle lanes would cause many bicyclists to feel stress because of factors such as multiple lanes, high bicycle volumes, high motor traffic volumes (9,000-30,000 ADT), higher traffic speeds (25+ mph), high incidence of double parking, higher truck traffic (10% of total ADT) and high parking turnover.
- Along streets for which conflicts at intersections can be effectively mitigated using parking lane setbacks, bicycle markings through the intersection, and other signalized intersection treatments.

Design Features

(A) Pavement markings, symbols and/or arrow markings must be placed at the beginning of the separated bikeway and at intervals along the facility based on engineering judgment to define the bike direction. (CA MUTCD 9C.04)

(B) 7 foot width preferred in areas with high bicycle volumes or uphill sections to facilitate safe passing behavior (5 foot minimum). (HDM 1003.1(1))

(C) 3 foot minimum buffer width adjacent to parking lines (2 foot minimum when adjacent to travel lanes), marked with 2 solid white (DIB 89, 2015).

Parked cars serve as a barrier between bicyclists and the vehicle lane. Barriers could also include flexible posts, bollards, planters, or other design elements Source: Bike East Bay.

Further Considerations

Separated bikeway buffers and barriers are covered in the CAMUTCD as preferential lane markings (section 3D.01) and channelizing devices (section 3H.01). If the buffer area is 4 feet or wider, white chevron or diagonal markings should be used (section 9C.04). Curbs may be used as a channeling device, see the section on islands (section 3I.01). Grade-separation provides an enhanced level of separation in addition to buffers and other barrier types.

- Where possible, physical barriers such as removable curbs should be oriented towards the inside edge of the buffer to provide as much extra width as possible for bicycle use.
- A retrofit separated bikeway has a relatively low implementation cost compared to road reconstruction by making use of existing pavement and drainage and using a parking lane as a barrier.
- Gutters, drainage outlets and utility covers should be designed and configured as not to impact bicycle travel.

For clarity at major or minor street crossings, consider a dotted line (CA MUTCD Detail 39A - Bike Lane Intersection Line) for the buffer boundary where cars are expected to cross.

- Special consideration should be given at transit stops to manage bicycle and pedestrian interactions. For design guidance, refer to VTA's Bus Stop Boarding Islands Memo (November 2020).

Materials and Maintenance

Bikeway striping and markings will require higher maintenance where vehicles frequently traverse over them at intersections, driveways, parking lanes, and along curved or constrained segments of roadway. Green conflict striping (if used) will also generally require higher maintenance due to vehicle wear.

Bikeways should be maintained so that there are no pot holes, cracks, uneven surfaces or debris.

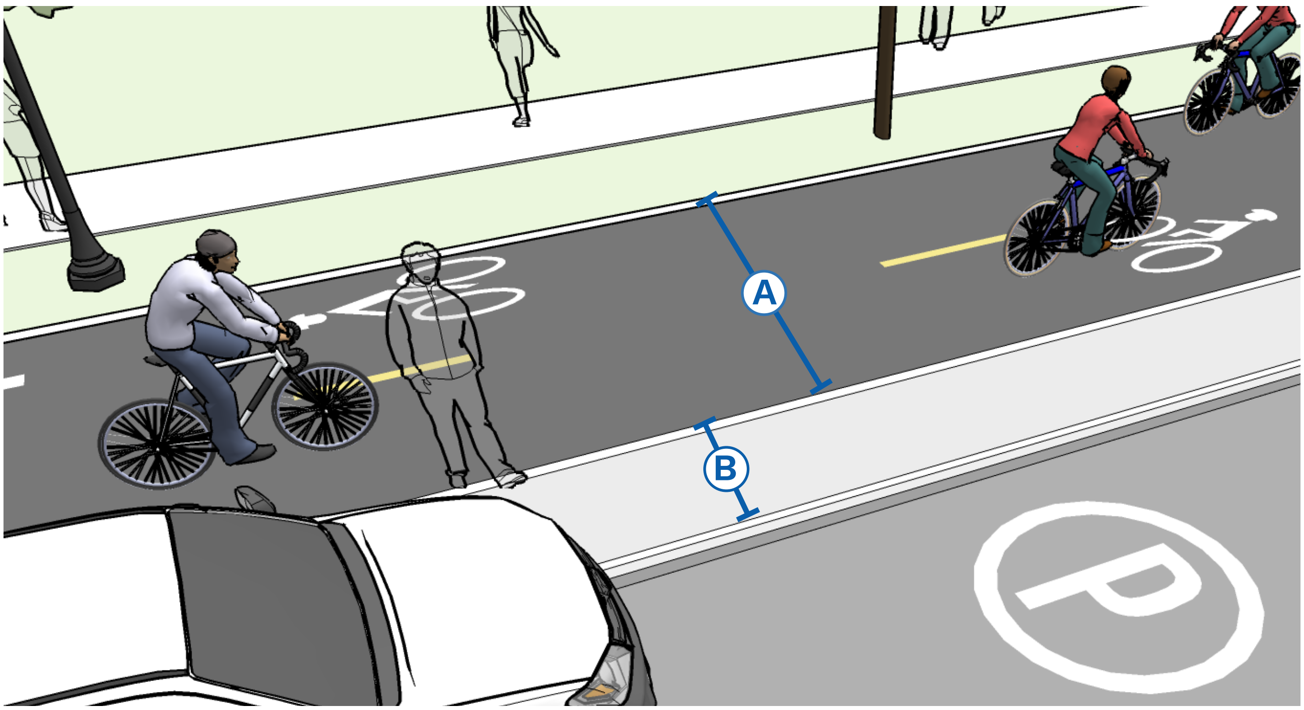
Access points along the facility should be provided for street sweeper vehicles to enter/exit the separated bikeway,

Approximate Cost

Separated bikeway construction costs can vary drastically depending on the type of separation used, the amount of new curb and gutter, stormwater mitigation, and crossing treatments. On the lower end of the scale, construction of a striped parking protected bikeway without delineators or other vertical elements can cost as little as $250,000 to $350,000 per mile.

Class IV Bikeway: Two-Way Separated

Two-Way Separated Bikeways are bicycle facilities that allow bicycle movement in both directions on one side of the road. Two-way separated bikeways share some of the same design characteristics as one-way separated bikeways, but often require additional considerations at driveway and side-street crossings, and intersections with other bikeways.



Typical Use

- Works best on the left side of one-way streets.
- Streets with high motor vehicle volumes and/or speeds
- Streets with high bicycle volumes.
- Streets with a high incidence of wrong-way bicycle riding.
- Streets with few conflicts such as driveways or cross-streets on one side of the street.
- Streets that connect to shared use paths.

Design Features

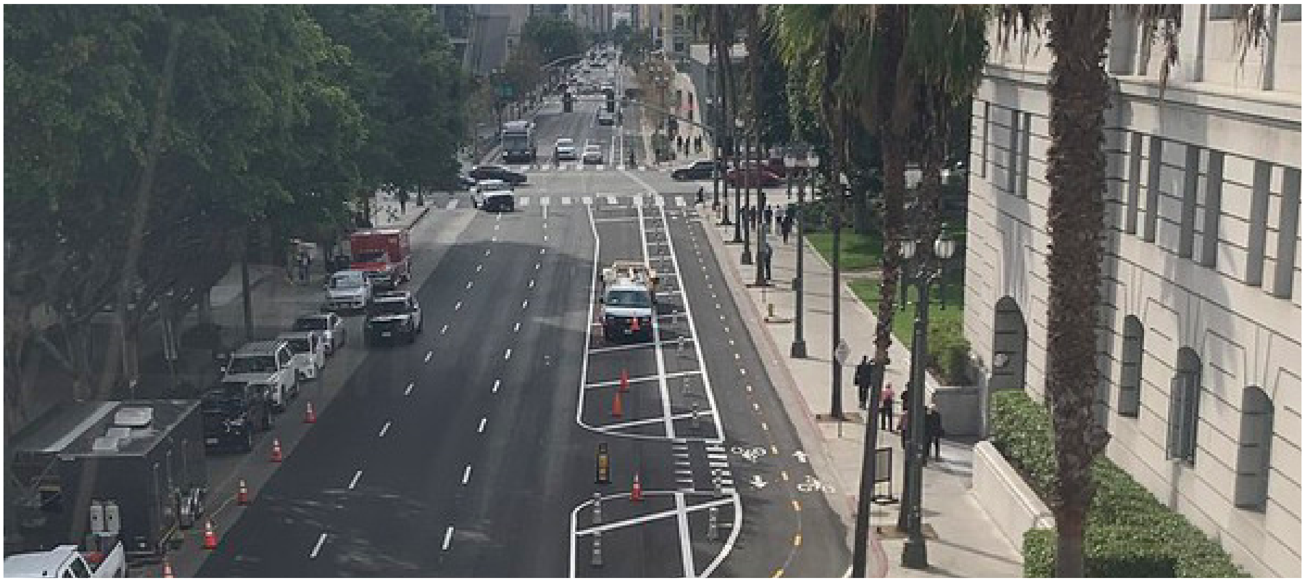
(A) 12 foot operating width preferred (10 ft minimum) width for two-way facility.

- In constrained locations an 8 foot minimum operating width may be considered (HDM 1003.1(1)).

(B) Adjacent to on-street parking a 3 foot minimum width channelized buffer or island shall be provided to accommodate opening doors (NACTO, 2012) (CA MUTCD 3H.01, 3I.01).

- A separation narrower than 5 feet may be permitted if a physical barrier is present. (AASHTO, 2013)

TWO-WAY SEPARATED BIKEWAY



A two-way facility can accommodate cyclists in two directions of travel.

- Additional signalization and signs may be necessary to manage conflicts.

Further Considerations

- On-street bikeway buffers and barriers are covered in the CA MUTCD as preferential lane markings (section 3D.01) and channelizing devices, including flexible delineators (section 3H.01). Curbs may be used as a channeling device, see the section on islands (section 3I.01).
- A two-way separated bikeway on one way street should be located on the left side.
- A two-way separated bikeway may be configured at street level or as a raised separated bikeway with vertical separation from the adjacent travel lane.
- Two-way separated bikeways should ideally be placed along streets with long blocks and few driveways or mid-block access points for motor vehicles.
- See Caltrans Design Information Bulletin No. 89 for more details.
- Special consideration should be given at transit stops to manage bicycle and pedestrian interactions. For design guidance, refer to VTA's Bus Stop Boarding Islands Memo (November 2020).

Materials and Maintenance

Bikeway striping and markings will require higher maintenance where vehicles frequently traverse over them at intersections, driveways, parking lanes, and along curved or constrained segments of roadway. Green conflict striping (if used) will also generally require higher maintenance due to vehicle wear.

Bikeways should be maintained so that there are no pot holes, cracks, uneven surfaces or debris.

Access points along the facility should be provided for street sweeper vehicles to enter/exit the separated bikeway.

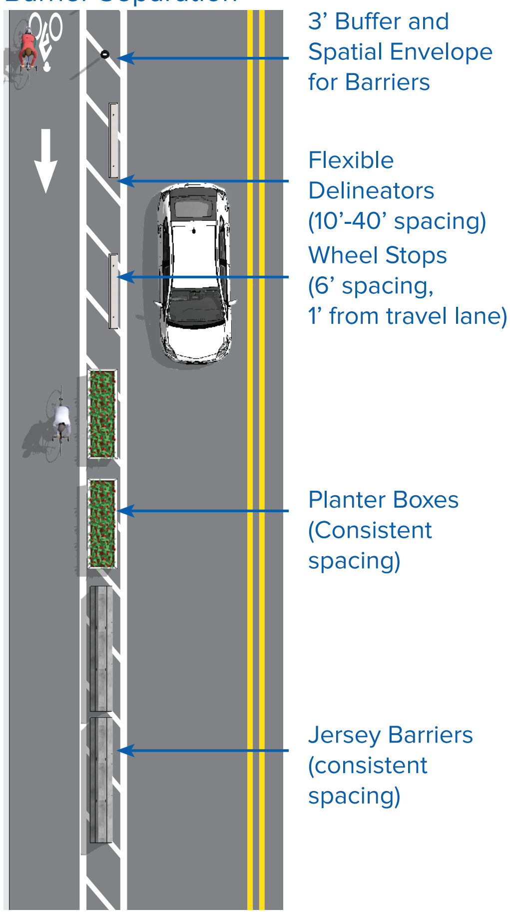
Approximate Cost

Separated bikway construction costs can vary drastically depending on the type of separation used, the amount of new curb and gutter, stormwater mitigation, and crossing treatments. On the lower end of the scale, construction of a striped parking protected bikeway with delineators or other vertical elements can cost as little as $310,000 per mile.

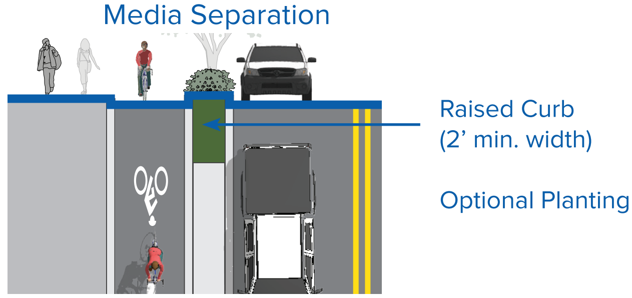
Class IV Separated Bikeway Barriers

Separated bikeways may use a variety of vertical elements to physically separate the bikeway from adjacent travel lanes. Barriers may be robust constructed elements such as curbs, or may be more interim in nature, such as flexible delineator posts.

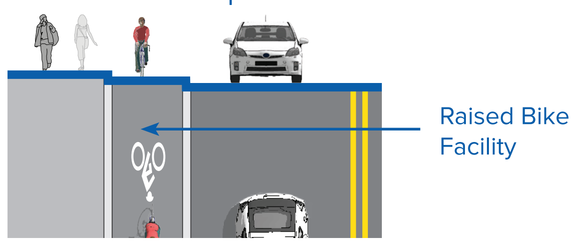
Barrier Separation



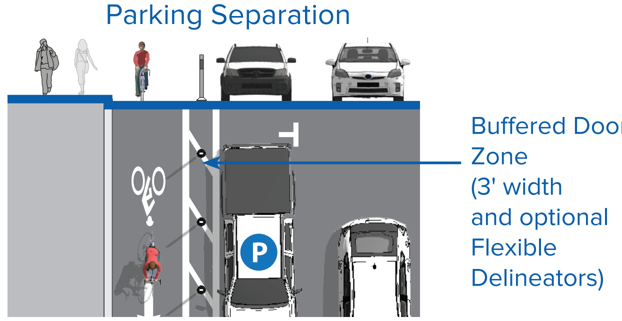
Media Separation



Grade Separation



Parking Separation



Typical Use

APPROPRIATE BARRIERS FOR RETROFIT PROJECTS:

- Parked Cars
- Flexible delineators
- Bollards
- Planters
- Parking stops

APPROPRIATE BARRIERS FOR RECONSTRUCTION PROJECTS:

- Curb separation
- Medians
- Landscaped Medians
- Raised separated bike lane with vertical or mountable curb
- Pedestrian Refuge Islands

Raised separated bikeway configurations around driveways and transit stops

Design Features

- Maximize effective operating space by placing curbs or delineator posts as far from the through bikeway space as practicable.
- Allow for adequate shy distance of 1 to 2 feet from vertical elements to maximize useful space.
- When next to parking allow for 3 feet of space in the buffer space to allow for opening doors and passenger unloading.
- Parking should be prohibited within 30 feet of the intersection to improve visibility.

Materials and Maintenance

Separated bikeways protected by concrete islands or other permanent physical separation, can be swept by smaller street sweeper vehicles.

Access points along the facility should be provided for street sweeper vehicles to enter/exit the separated bikeway.

Further Considerations

- Separated bikeway buffers and barriers are covered in the CA MUTCD as preferential lane markings **(section 3D.01)** and channelizing devices **(section 3H.01)**. Curbs may be used as a channeling device, see the section on islands **(section 3I.01)**.
- With new roadway construction a raised separated bikeway can be less expensive to construct than a wide or buffered bicycle lane because of shallower trenching and sub base requirements.
- The presences of landscaping in medians, planters and safety islands increases comfort for users and enhances the streetscape environment.

Approximate Cost

Separated bikeway barrier material costs can vary greatly, depending on the type of material, the scale, and whether it is part of a broader construction project.

SUPPORTING FACILITIES

Bike Parking

Bicyclists expect a safe, convenient place to secure their bicycle when they reach their destination. This may be short-term parking of 2 hours or less, or long-term parking for employees, students, residents, and commuters.

Typical Application

- Bike racks provide short-term bicycle parking and is meant to accommodate visitors, customers, and others expected to depart within two hours. It should be an approved standard rack, appropriate location and placement, and weather protection.
- On-street bike corrals (also known as on-street bicycle parking) consist of bicycle racks grouped together in a common area within the street traditionally used for automobile parking. Bicycle corrals are reserved exclusively for bicycle parking and provide a relatively inexpensive solution to providing high-volume bicycle parking. Bicycle corrals can be implemented by converting one or two on-street motor vehicle parking spaces into on-street bicycle parking. Each motor vehicle parking space can be replaced with approximately 6-10 bicycle parking spaces.
- Bicycle lockers are intended to provide long-term bicycle storage for employees, students, residents, commuters, and others expected to park more than two hours. Long-term facilities protect the entire bicycle, its components and accessories against theft and against inclement weather, including snow and wind-driven rain.
- A Secure parking Area for bicycles, also known as a BikeSPA or Bike & Ride (when located at transit stations), is a semi-enclosed space that offers a higher level of security than ordinary bike racks. Accessible via key-card, combination locks, or keys, BikeSPAs provide high-capacity parking for 10 to 100 or more bicycles. Increased security measures create an additional transportation option for those whose biggest concern is theft and vulnerability.

Bike Racks and Bike Lockers

Secure Parking Area

Design Features

BIKE RACKS

- 2 feet minimum from the curb face to avoid 'dooring.'
- 4 feet between racks to provide maneuvering room.
- Locate close to destinations; 50 feet maximum distance from main building entrance.
- Minimum clear distance of 6 feet should be provided between the bicycle rack and the property line.

BIKE CORRALS

- Bicyclists should have an entrance width from the roadway of 5-6 feet.
- Can be used with parallel or angled parking.
- Parking stalls adjacent to curb extensions are good candidates for bicycle corrals since the concrete extension serves as delimitation on one side.

BIKE LOCKERS

- Minimum dimensions: width (opening) 2.5 feet; height 4 feet; depth 6 feet.
- 4 foot side clearance and 6 foot end clearance.
- 7 foot minimum distance between facing lockers.

SECURE PARKING AREA

- Closed-circuit television monitoring with secure access for users.
- Double high racks & cargo bike spaces.
- Bike repair station with bench and bike tube and maintenance item vending machine.
- Bike lock "hitching post" – allows people to leave bike locks.

Construction Costs

Costs can vary based on the design and materials used. Bicycle rack costs can range from approximately $60 to $3,600, depending on design and materials used. On average the cost is approximately $660. Bicycle lockers costs range from $1,280 to $2,680, and secure parking areas are approximately $250,000

Wayfinding Sign Types

The ability to navigate through a city is informed by landmarks, natural features and other visual cues. Signs throughout the city should indicate to bicyclists the direction of travel, the locations of destinations and the travel time/distance to those destinations. A bicycle wayfinding system consists of comprehensive signing and/or pavement markings to guide bicyclists to their destinations along preferred bicycle routes.

Typical Application

- Wayfinding signs will increase users' comfort and accessibility to the bicycle systems.
- Signage can serve both wayfinding and safety purposes including:
- Helping to familiarize users with the bicycle network
- Helping users identify the best routes to destinations
- Helping to address misperceptions about time and distance
- Helping overcome a "barrier to entry" for people who are not frequent bicyclists (e.g., "interested but concerned" bicyclists)

Design Features

- Confirmation signs indicate to bicyclists that they are on a designated bikeway. Make motorists aware of the bicycle route. Can include destinations and distance/time but do not include arrows.
- Turn signs indicate where a bikeway turns from one street onto another street. These can be used with pavement markings and include destinations and arrows.
- Decisions signs indicate the junction of two or more bikeways and inform bicyclists of the designated bike route to access key destinations. These include destinations, arrows and distances. Travel times are optional but recommended.

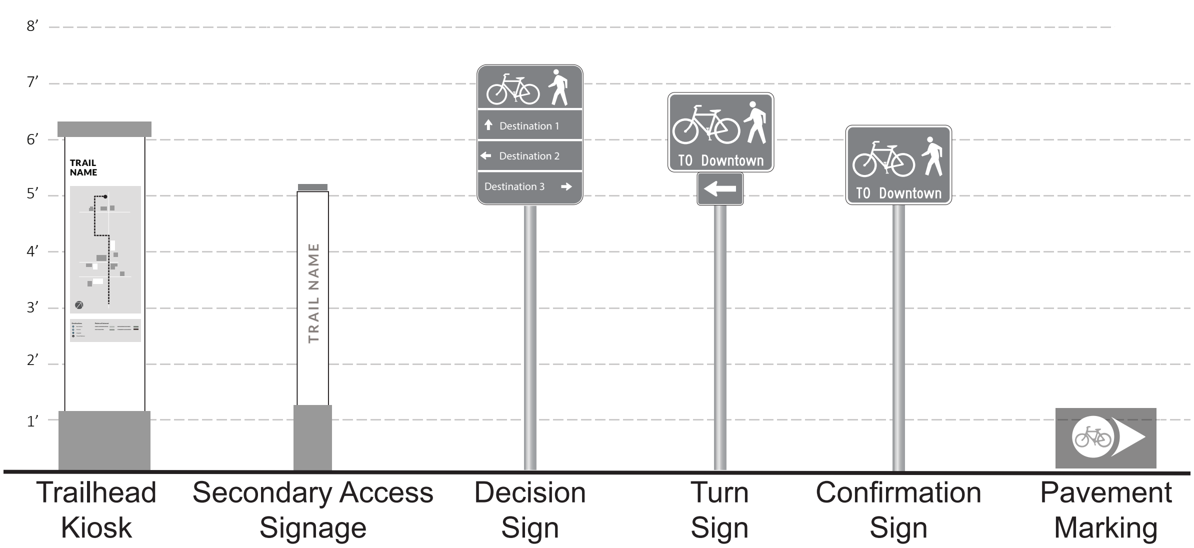
Further Considerations

- Bicycle wayfinding signs also visually cue motorists that they are driving along a bicycle route and should use caution. Signs are typically placed at key locations leading to and along bicycle routes, including the intersection of multiple routes.
- Too many road signs tend to clutter the right-of-way, and it is recommended that these signs be posted at a level most visible to bicyclists rather than per vehicle signage standards.
- A community-wide bicycle wayfinding signage plan would identify:
- Sign locations
- Sign type – what information should be included and design features
- Destinations to be highlighted on each sign – key destinations for bicyclists
- Approximate distance and travel time to each destination

- Green is the color used for directional guidance and is the most common color of bicycle wayfinding signage in the US, including those in the CAMUTCD.
- Check wayfinding signage along bikeways for signs of vandalism, graffiti, or normal wear and replace signage along the bikeway network as-needed.

Approximate Cost

Trail wayfinding signs range from $500-$2000.



ENHANCED CROSSING TREATMENTS


BART Way
CARING FOR YOU OUR PATIENTS
SPEED LIMIT 25

Marked Crosswalks

A marked crosswalk signals to motorists that they must stop for pedestrians and encourages pedestrians to cross at designated locations. Installing crosswalks alone will not necessarily make crossings safer especially on multi-lane roadways. At mid-block locations, crosswalks can be marked where there is a demand for crossing and there are no nearby marked crosswalks.

Typical Application

All crosswalks should be marked at controlled intersections. At uncontrolled intersections, crosswalks should be marked under the following conditions:

- At a complex intersection, to orient pedestrians in finding their way across.
- At an offset intersection, to show pedestrians the shortest route across traffic with the least exposure to vehicular traffic and traffic conflicts.
- At an intersection with visibility constraints, to position pedestrians where they can best be seen by oncoming traffic.
- At an intersection within a school zone on a walking route.

Design Features

- The crosswalk should be located to align as closely as possible with the through pedestrian zone of the sidewalk corridor
- The landing at the top of a ramp shall be at least 4 feet long and at least the same width as the ramp itself.
- The ramp shall slope no more than 8.33%, with a maximum cross slope of 2.0%.
- If the ramp runs directly into a crosswalk, the landing at the bottom will be in the roadway.
- If the ramp lands on a dropped landing within the sidewalk or corner area where someone in a wheelchair may have to change direction, the landing must be a minimum of 5’-0” long and at least as wide as the ramp itself.

Further Considerations

Continental crosswalk markings should be used at crossings with high pedestrian use or where vulnerable pedestrians are expected, including: school crossings, across arterial streets for pedestrian-only signals, at mid-block crosswalks, and at intersections where there is expected high pedestrian use and the crossing is not controlled by signals or stop signs. High-visibility crosswalks are not appropriate for all locations. See intersection signalization for a discussion of enhancing pedestrian crossings.

Because the effectiveness of marked crossings depends entirely on their visibility, maintaining marked crossings should be a high priority. Thermoplastic markings offer increased durability than conventional paint.

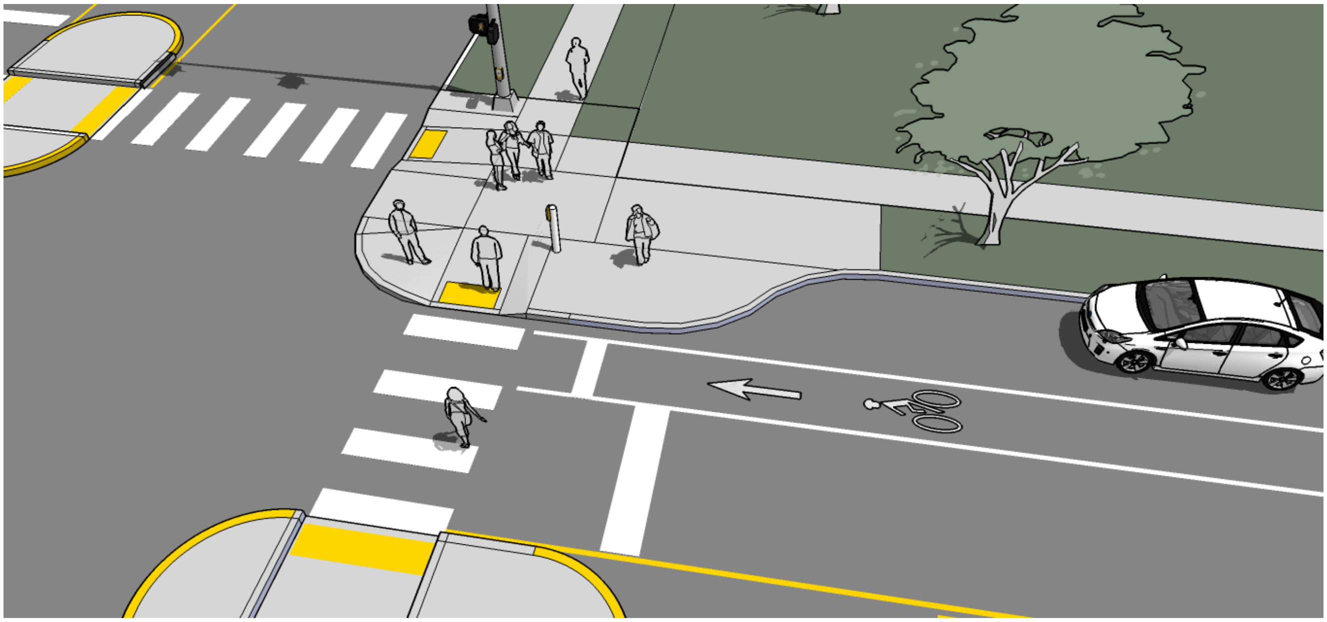
in order to require a three-stage pedestrian crossing. Intersections with three-stage crossings lead to arduous and increased crossing distances, pedestrian frustration, encourages jaywalking, and exhibits modal bias favoring motor vehicle level-of-service over other modes.

Approximate Cost

Standard transverse marked crosswalks range from approximately $1,500 to $3000 per intersection leg. High-visibility crosswalks, such as Continental-style crossings, can range from $2,500 to $5,000 per intersection leg

Curb Extensions

Curb extensions minimize pedestrian exposure during crossing by shortening crossing distance and giving pedestrians a better chance to see and be seen before committing to crossing.



Typical Application

- Within parking lanes appropriate for any crosswalk where it is desirable to shorten the crossing distance and there is a parking lane adjacent to the curb.
- May be possible within non-travel areas on roadways with excess space.
- Particularly helpful at midblock crossing locations.
- Curb extensions should not impede bicycle travel in the absence of a bike lane.
- When a bike lane is present, the curb extensions should terminate one foot short of the parking lane to maximize bicyclist safety.
- Reduces pedestrian crossing distance by 6-8 ft.
- Planted curb extensions may be designed as a bioswale for stormwater management.

Design Features

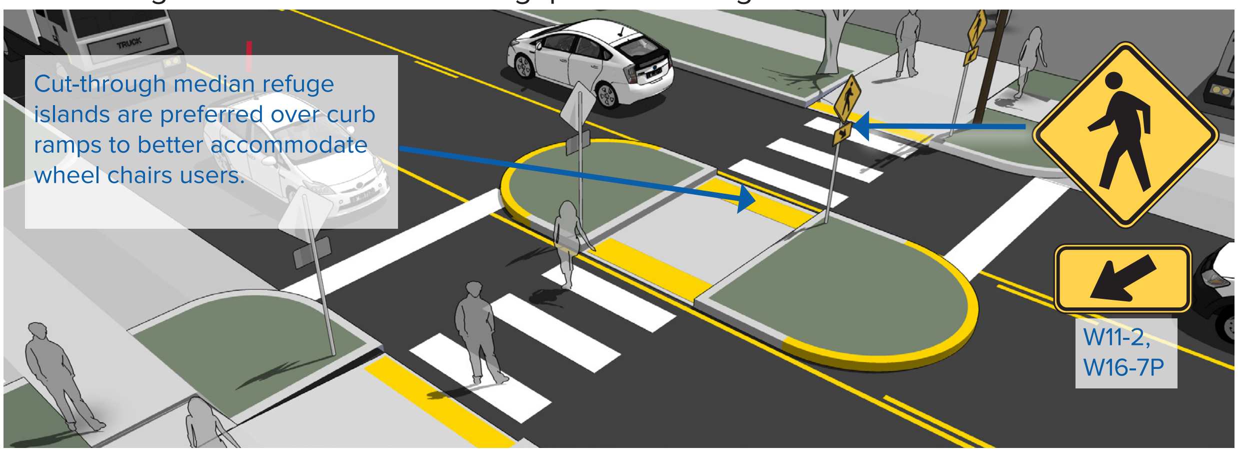
- For purposes of efficient street sweeping, the minimum radius for the reverse curves of the transition is 10 ft and the two radii should be balanced to be nearly equal.

Approximate Cost

The cost of a curb extension can range from $10,000 to $40,000 depending on the design and site condition, with the typical cost approximately $13,000. .

Median Refuge Islands

Median refuge islands are located at the mid-point of a marked crossing and help improve pedestrian access by increasing pedestrian visibility and allowing pedestrians to cross one direction of traffic at a time. Refuge islands minimize pedestrian exposure at mid-block crossings by shortening the crossing distance and increasing the number of available gaps for crossing.



Typical Use

- Refuge islands an be applied on any roadway with a left turn center lane or median that is at least 6' wide (to accommodate wheelchair users) and at least 20' long (40' minimum preferred). Islands are appropriate at signalized or unsignalized crosswalks.
- The refuge island must be accessible, preferably with an at-grade passage through the island rather than ramps and landings.
- Provide double centerline marking, reflectors, and "KEEP RIGHT" signage (CA MUTCD R4-7a) in the island on streets with posted speeds above 25 mph.

Design Features

- Median refuge islands can be installed on roadways with existing medians or on multi-lane roadways where adequate space exists
- Median Refuge Islands should always be paired with crosswalks, and should include advance pedestrian warning signage when installed at uncontrolled crossings.
- On multi-lane roadways, consider configuration with active warning beacons for improved yielding compliance.

Materials and Maintenance

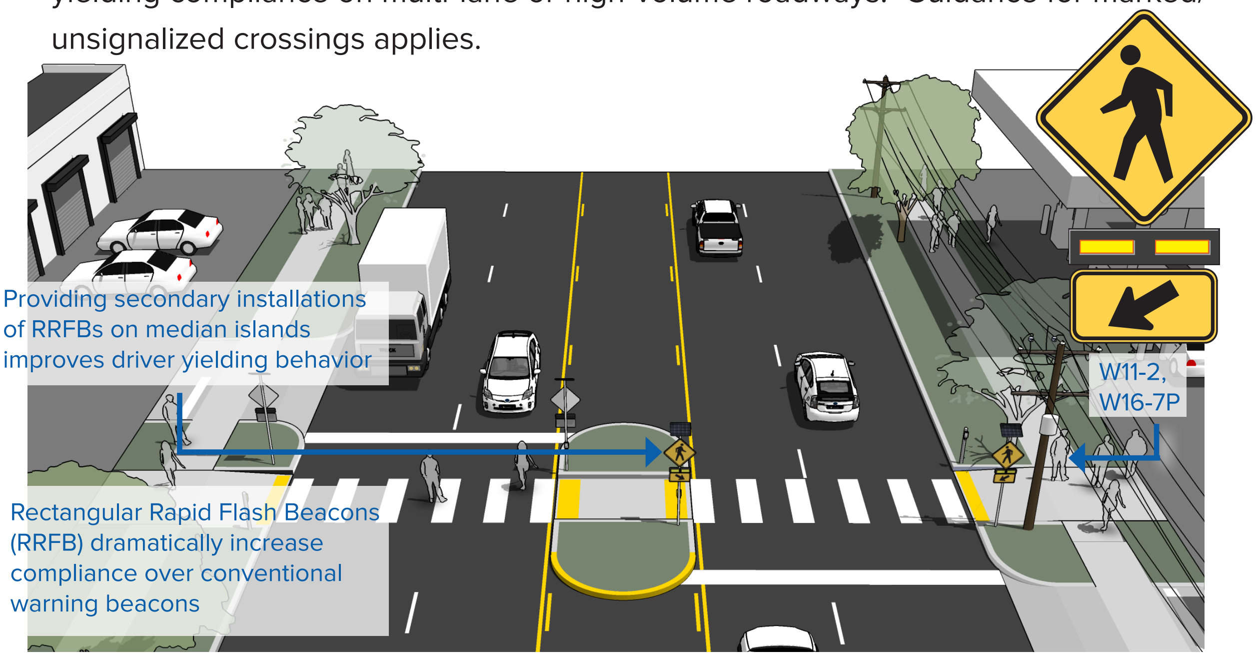
Refuge islands may require frequent maintenance of road debris. Trees and plantings in a landscaped median must be maintained so as not to impair visibility, and should be no higher than 1 foot 6 inches.

Approximate Cost

The approximate cost to install a median refuge island ranges from $10,00 to $40,000, depending on the design, site conditions, landscaping, and whether the median can be added as a part of a larger street reconstruction project or utility upgrade.

Rectangular Rapid Flashing Beacons (RRFB)

Rectangular Rapid Flash Beacons (RRFB) are a type of active warning beacon used at unsignalized crossings. They are designed to increase motor vehicle yielding compliance on multi-lane or high-volume roadways. Guidance for marked/ unsignalized crossings applies.



Typical Use

RRFBs are typically activated by pedestrians manually with a push button, or can be actuated automatically with passive detection systems.

RRFBs shall not be used at crosswalks controlled by YIELD signs, STOP signs, or traffic control signals.

RRFBs shall initiate operation based on user actuation and shall cease operation at a predetermined time after the user actuation or, with passive detection, after the user clears the crosswalk.

Materials and Maintenance

RRFBs should be regularly maintained to ensure that all lights and detection hardware are functional.

Design Features

Guidance for marked/unsignalized crossings applies.

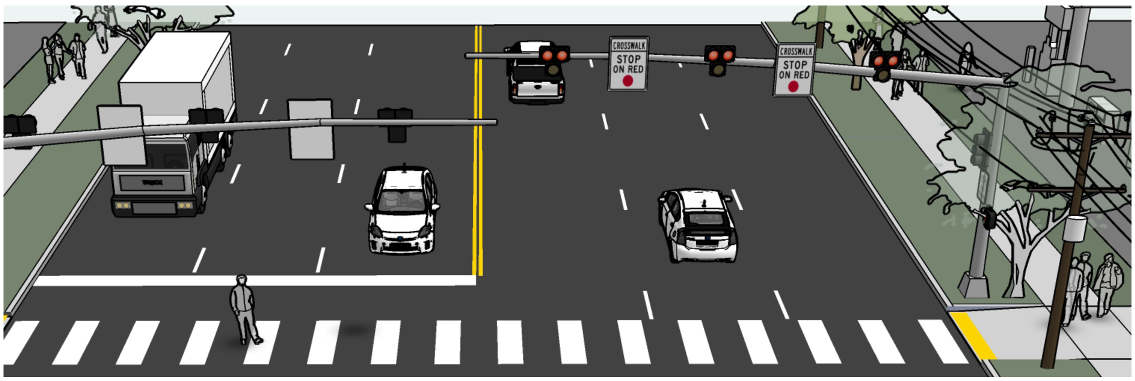
- A study of the effectiveness of going from a no-beacon arrangement to a two-beacon RRFB installation increased yielding from 18 percent to 81 percent. A four-beacon arrangement raised compliance to 88%. Additional studies of long term installations show little to no decrease in yielding behavior over time.
- See FHWA Interim Approval 21 (IA-21) for more information on device application standards.

Approximate Cost

RRFBs range in price from $14,000 to $50,000 for a solar powered unit depending on the location, width of the road and other factors.

Pedestrian Hybrid Beacon (HAWK)

Hybrid beacons or High-Intensity Activated Crosswalk (HAWK) beacons are used to improve unsignalized intersections or midblock crossings of major streets. It consists of a signal head with two red lenses over a single yellow lens on the major street, and a pedestrian signal head for the crosswalk. The signal is only activated when a pedestrian and/or bicyclist is present, resulting in minimal delay for motor vehicle traffic.



Typical Use

HAWK beacons are only used at marked mid-block crossings or unsignalized intersections. They are typically activated with a pedestrian pushbutton at each end. If a median refuge island is used at the crossing, another pedestrian pushbutton can be located on the island to create a two-stage crossing.

Design Features

- Hybrid beacons may be installed without meeting traffic signal control warrants if roadway speed and volumes are excessive for comfortable pedestrian crossings.
- If installed within a signal system, signal engineers should evaluate the need for the hybrid signal to be coordinated with other signals.

HAWK beacons should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs. Parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the marked crosswalk to provide adequate sight distance. (CA MUTCD 4F)

Further Considerations

- HAWK beacons may also be actuated by infrared, microwave, or video detectors.
- Each crossing, regardless of traffic speed or volume, requires additional review by a registered engineer to identify sight lines, potential impacts on traffic progression, timing with adjacent signals, capacity, and safety.
- The installation of HAWK beacons should also include public education and enforcement campaigns to ensure proper use and compliance.

Materials and Maintenance

Hybrid beacons are subject to the same maintenance needs and requirements as standard traffic signals. Signing and striping need to be maintained to help users understand any unfamiliar traffic control.

Approximate Cost

Hybrid beacons are more expensive than other beacons, ranging in costs from $50,000 to $130,000, but are generally less expensive than full signals.

Bike Detection and Actuation

Bicycle detection and actuation is used to alert the signal controller of bicycle crossing demand on a particular approach. Proper bicycle detection should meet two primary criteria: accurately detects bicyclists and provides clear guidance to bicyclists on how to actuate detection (e.g., what button to push, where to stand).

Typical Application

- At signalized intersections within bicycle lanes or general purpose travel Lanes
- At signalized intersections within left turn lanes used by bicyclists
- At signalized intersections within separated bike lanes.
- In conjunction with active warning beacons and pedestrian hybrid beacons.

Design Features

PUSH BUTTON ACTUATION

- User-activated button mounted on a pole facing the street.
- The location of the device should not require bicyclists to dismount or be rerouted out of the way or onto the sidewalk to activate the phase. Signage should supplement the signal to alert bicyclists of the required activation to prompt the green phase.

LOOP DETECTORS

- Loop detectors are bicycle-activated and installed within the roadway to allow the presence of a bicycle to trigger a change in the traffic signal. This allows the bicyclist to stay within the lane of travel without having to maneuver to the side of the road to trigger a push button.
- Loops should be sensitive enough to detect bicycles should be supplemented with pavement markings to instruct bicyclists how to trip them.
- The CAMUTCD provides guidance on stencil markings and signage related to signal detection.

VIDEO DETECTION

- Video detection systems use digital image processing to detect a change in the image at a location. These systems can be calibrated to detect bicycle, although there may be detection issues during poor lighting and weather conditions.
- Remote Traffic Microwave Sensor Detection (RTMS)
- RTMS is a system which uses frequency modulated continuous wave radio signals to detect objects in the roadway. This method marks the detected object with a time code to determine its distance from the sensor.
- The RTMS system is unaffected by temperature and lighting, which can affect standard video detection.

User-activated button mounted on a pole

Bicycle loop detection

Further Considerations

- Bicycle loops and other detection mechanisms can also provide bicyclists with an extended green time before the light turns yellow so that bicyclists of all abilities can reach the far side of the intersection.
- User comprehension of the bicycle detector Pavement markings is low, although some treatments show promise in increasing proper usage. Researchers at Portland State University found that 23.5% of bicyclists correctly positioned themselves over the stand-alone marking, use increased to 34.8% when the marking was paired with a R10-22 sign, and increased further to 48.4% when installed over a green background .

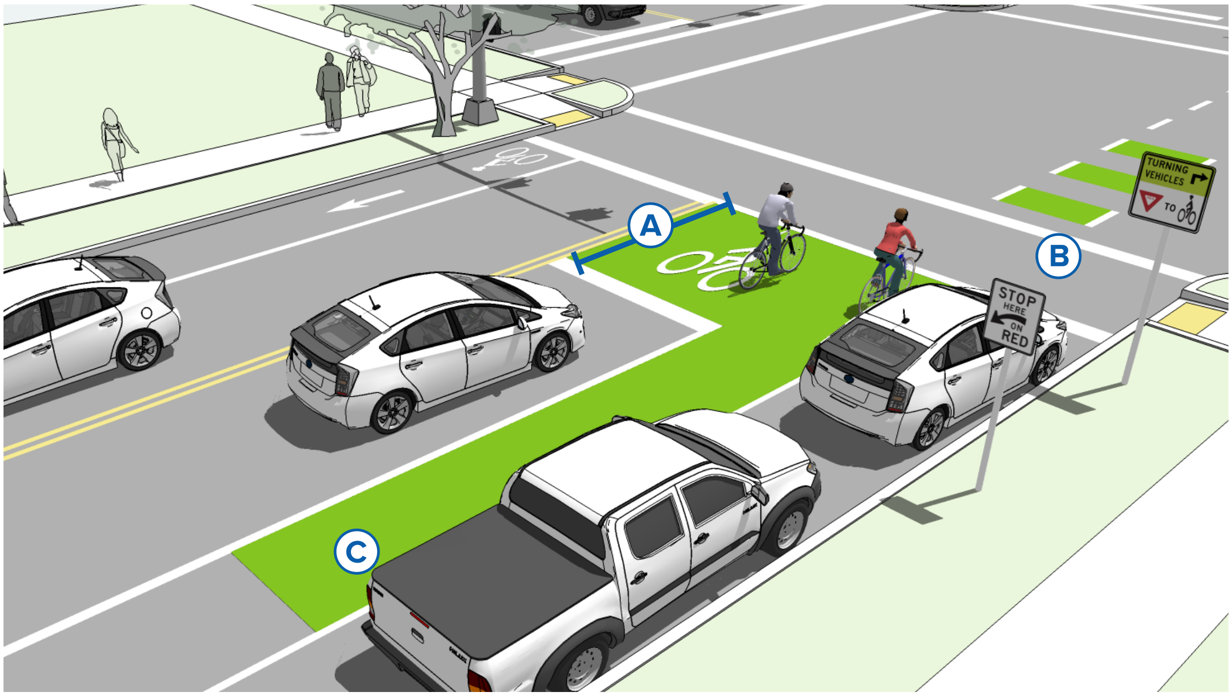
Approximate Cost

Costs vary depending on the type of technology used, but bicycle loop detectors embedded in the pavement are $2,000 on average, and can range from $1,500 to $3,000

Video detection camera system costs range from $20,000 to $25,000 per intersection.

Bicycle Box

A bicycle box is an experimental treatment, designed to provide bicyclists with a safe and visible space to get in front of queuing traffic during the red signal phase. Motor vehicles must queue behind the white stop line at the rear of the bike box. On a green signal, all bicyclists can quickly clear the intersection. This treatment is currently under experiment, and has not been approved by Caltrans.



Typical Use

- At potential areas of conflict between bicyclists and turning vehicles, such as a right or left turn locations.
- At signalized intersections with high bicycle volumes.
- At signalized intersections with high vehicle volumes.
- Not to be used on downhill approaches to minimize the right hook threat potential during the stale green signal phase.

Design Features

(A) 14 foot minimum depth from back of crosswalk to motor vehicle stop bar. **(NACTO, 2012)**

(B) A "No Turn on Red" **(CA MUTCD R10-11)** or "No Right Turn on Red" **(CA MUTCD R13A)** sign shall be installed overhead to prevent vehicles from entering the Bike Box. (Refer to CVC 22101 for the signage) A "Stop Here on Red" **(CA MUTCD R10-6)** sign should be post mounted at the stop line to reinforce observance of the stop line.

(C) A 50 foot ingress lane should be used to provide access to the box.

- Use of green colored pavement is recommended.

A bike box allows for cyclists to wait in front of queuing traffic, providing high visibility and a head start over motor vehicle traffic.

Further Considerations

- This treatment positions bicycles together and on a green signal, all bicyclists can quickly clear the intersection, minimizing conflict and delay to transit or other traffic.
- Pedestrian also benefit from bike boxes, as they experience reduced vehicle encroachment into the crosswalk.
- Bike boxes are currently under experiment in California. Projects will be required to go through an official Request to Experiment process. This process is outlined in Section 1A.10 in the CAMUTCD, and jurisdictions must receive approval prior to implementation.

Materials and Maintenance

Bike boxes are subject to high vehicle wear, especially turning passenger vehicles, buses, and heavy trucks. As a result, bike boxes with green coloring will require more frequent replacement over time. The life of the green coloring will depend on vehicle volumes and turning movements, but Thermoplastic is generally a more durable material than paint.

Approximate Cost

Costs will vary due to the type of paint or thermoplastic used and the size of the bike box, as well as whether the treatment is added at the same time as other road treatments.

Typical costs range from $1.20/sq. ft. installed for paint to $14/sq. ft. installed for Thermoplastic.

Two-Stage Turn Boxes

Two- stage turn boxes offer bicyclists a safe way to make turns at multi-lane signalized intersections from a physically separated or conventional bike lane.

On separated bike lanes, bicyclists are often unable to merge into traffic to turn due to physical separation, making the provision of two-stage turn boxes critical.

Typical Application

- Streets with high vehicle speeds and/or traffic volumes.
- At intersections of multi-lane roads with signalized intersections.
- At signalized intersections with a high number of bicyclists making a left turn from a right side facility.
- Preferred treatment to assist turning maneuvers on bike lanes, instead of requiring bicyclists to merge to make a vehicular left turn.
- Required for protected bikeways to assist left turns from a right side facility, or right turns from a left side facility.

Design Features

- The two-stage turn box shall be placed in a protected area. Typically this is within the shadow of an on-street parking lane or protected bike lane buffer area and should be placed in front of the crosswalk to avoid conflict with pedestrians.
- 8 foot x 6 foot preferred dimensions of bicycle storage area (6 foot x 3 foot minimum).
- Bicycle stencil and turn arrow pavement markings shall be used to indicate proper bicycle direction and positioning. (NACTO, 2012)

Further Considerations

- Consider providing a “No Turn on Red” (CAMUTCD R10-11) on the cross street to prevent motor vehicles from entering the turn box.
- This design formalizes a maneuver called a “box turn” or “pedestrian style turn.”
- Some two-stage turn box designs are considered experimental by FHWA and is not currently under experiment in California.
- Design guidance for two-stage turns apply to both bike lanes and separated bike lanes.
- Two-stage turn boxes reduce conflicts in multiple ways; from keeping bicyclists from queuing in a bike lane or crosswalk and by separating turning bicyclists from through bicyclists.
- Bicyclist capacity of a two-stage turn box is influenced by physical dimension (how many bicyclists it can contain) and signal phasing (how frequently the box clears.)

Materials and Maintenance

Turn boxes may subject to high vehicle wear, especially turning passenger vehicles, buses, and heavy trucks. As a result, bike boxes with green coloring will require more frequent replacement over time. The life of the green coloring will depend on vehicle volumes and turning movements, but Thermoplastic is generally a more durable material than paint.

Approximate Cost

Costs will vary due to the type of paint used and the size of the two-stage turn box, as well as whether the treatment is added at the same time as other road treatments.

Typical costs range from $1.20/sq. ft. installed for paint to $14/sq. ft. installed for Thermoplastic.

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APPENDIX F

Cost Estimates

Planning level cost estimates are included for each project, as shown in the Implementation chapter of the plan. These costs represent high level estimates based on the project type to guide planning and implementation strategy. Costs are provided by project type. As projects advance toward implementation, more detailed cost estimates should be completed based on an engineering review and further analysis of the site context.

The planning level cost estimates used to inform the project costs are shown in the following tables. The estimates are based on the planning costs for comparable projects in nearby jurisdictions and do not include costs for design.

TABLE 1 *Cost Estimates: Priority Pedestrian Spot Recommendations*

PROJECT TYPE	NOTES	UNIT	COST ESTIMATE	COMMERCIAL SIGNALIZED	COMMERCIAL UNSIGNALIZED	NEIGHBORHOOD SIGNALIZED	NEIGHBORHOOD UNSIGNALIZED
Curb Extension	Per corner. No utility or storm drain relocations. Cost depends on size of intersection, whether regrading of intersection required.	EA (each)	$750,000	x	x	x	
Modify Skewed Intersection(s)	Varies by intersection	EA	$750,000	x	x	x	
Parking Restrictions	Red thermoplastic paint at curb, signage	LF (linear foot	$50		x	x	
Right-Turn Slip Lane Removal(s)	No utility or storm drain relocations included	EA	$600,000	x	x	x	
Transit Waiting Area Improvements/ Bus Shelter	Varies by type	EA	$400,000	x	x		
Sidewalk	Construction cost is the base cost of $10/ square foot for a six foot wide sidewalk.	LF	$60				
High Visibility Crosswalk Marking(s)	One leg, cost varies by length of crosswalk and color	LF	$25	x	x	x	x
Advance Yield/ Stop Line(s)	Thermoplastic paint	LF	$20	x	x	x	x
Curb Ramp(s)	No utility or storm drain relocations	EA	$10,000	x	x	x	x

TABLE 1 *Cost Estimates: Priority Pedestrian Spot Recommendations (continued)*

PROJECT TYPE	NOTES	UNIT	COST ESTIMATE	COMMERCIAL SIGNALIZED	COMMERCIAL UNSIGNALIZED	NEIGHBORHOOD SIGNALIZED	NEIGHBORHOOD UNSIGNALIZED
Pedestrian Refuge Island(s)	No utility or storm drain relocations. Cost varies with size of crossing.	SF (square foot)	$1,000		x	x	x
Raised Pedestrian Crossing(s)	Varies by length of crossing. No utility or storm drain relocations.	EA	$8,000			x	x
Overhead Crosswalk Lighting	Varies by type and location	LS (lump sum)	$500,000	x	x	x	x
Pedestrian Crosswalk Motion Sensor(s)	Per leg of crosswalk.	EA	$30,000		x		x
Rectangular Rapid Flashing Beacon (RRFB)		EA	$100,000				
Pedestrian Hybrid Beacon (PHB)		EA	$500,000		x		
Traffic and Pedestrian Signal Changes (Leading Pedestrian Intervals, Pedestrian countdown signal, no right on red, etc.)	Per intersection. Costs vary by type of change and equipment required.	LS	$50,000	x		x	
Signage		EA	$500				x

TABLE 2 *Cost Estimates: Linear Bikeway Recommendations*

PROJECT TYPE	NOTES	PLANNING LEVEL COST PER MILE (AVERAGE)
Class I: Paved Shared Use Path	Includes minor crossing improvements. Does not include signal modification or right of way acquisition. Assume high cost for creekside trails	$1,500,000
Class II: Bike Lane	Low cost assumes signage, striping. High cost assumes green conflict marking, traffic signal modification including bike signal detection.	$260,000
Class IIB: Buffered Bike Lane	Low cost assumes signage, striping, and a painted buffer. High cost assumes green conflict marking, traffic signal modification including bike signal detection, and wayfinding signage.	$296,000
Class IIIB: Bicycle Blvd	Low cost assumes signage, striping, and minor traffic calming such as speed humps, and up to 3 other elements such as medians, diverters or a raised crosswalk. High cost assumes low cost items plus traffic circles, curb extensions, traffic signal modification including bike signal detection, and wayfinding signage.	$548,000
Class IV: Cycle Track	Low cost assumes signage, striping, and a painted buffer with flexible delineators. High cost assumes green conflict marking, traffic signal modification including bike signal detection, and a raised concrete buffer.	$1,307,000

TABLE 3 *Cost Estimates: Priority Bike Spot Recommendations*

PROJECT CATEGORY	NOTES	COST PER FOOT
Bike Lane Connectivity (short-term)	Striping and signage	$75

TABLE 4 *Cost Estimates: Priority Trail Spot Recommendations*

PROJECT TYPE	NOTES	UNIT	PLANNING LEVEL COST ESTIMATE
Trail Access Improvement			
Trail Access	New connections and access to the trail network, as well as improvements to roadway crossings; similar crossing improvements as described in the pedestrian spot improvements and depends upon whether the crossing is signalized or unsignalized.	n/a	varies
Pedestrian Hybrid Beacon		EA	$650,000
Signage		EA	$500
High Visibility Crosswalk Marking(s)		LF (Linear Foot)	$25
Pedestrian Refuge Island(s)		SF (Square Foot)	$2,000
Traffic and Pedestrian Signal Changes		LS (Lump Sum)	$1,000,000
Raised Pedestrian Crossing(s)		EA	$8,000
Curb Extension		EA	$750,000
Trailhead Improvement			
Restroom		EA	$125,000
Drinking Fountain		EA	$4,000
Map Kiosk		EA	$5,000
Waste Receptacles		EA	$1,000
Picnic Tables		EA	$1,500
Benches		EA	$1,000
Paved Plaza/Gathering Area		EA	$10
Bike Repair Station		EA	$1,500